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Forthcoming Event.

JULY 17.

Institute of British Foundrymen (Lancashire Branch):—Visit to the Works of Messrs. Hartley & Sugden, Limited, Halifax.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Future of the B.C.I.R.A.

After the recent inspection of the work and organisation of the British Cast Iron Research Association by an expert committee appointed by H.M. Government, a report was prepared by the Inspectors for the Department of Scientific and Industrial Research. We understand that this report, by courtesy of the Department, has been circulated to members as a confidential document, and is not intended for publication. We have, however, had an opportunity of reading not only this report, but also the memorandum submitted by the Council to the Government asking for support for a further term of five years. The Inspectors were given every facility for going into the work of the Association in detail, and were thus in a position to gain an even better impression of it than members themselves.

We do not think we should be breaking any confidence if we state that the report is highly satisfactory, and that it reflects very great credit on the Council and officers. That such a report should be entirely free from criticism and that it should express approval of every development undertaken is a result which two years ago could scarcely have been hoped for even by the most optimistic member of Council. The development of the laboratory at Birmingham, the amalgamation with the Falkirk Institute, the growth of investigations at the National Physical Laboratory and in university laboratories, all are commended as contributing to a sound policy. Similarly, further steps contemplated by the Council, notably the centralisation of headquarters, offices and laboratories, and the acquisition of an experimental foundry are considered to be desirable steps to take in the near future.

The subscriptions are criticised as being on the low side. The services offered are undoubted, and as the organisation gets into its stride they are bound to be increased in quantity and rendered more promptly. It might therefore seem somewhat surprising that the membership still represents only a fraction of the firms eligible. Naturally the trade slump and the prevalence of price-cutting has been responsible for a feeling in many quarters that it is essential to save every penny. There is, of course, a good deal of conservatism, coupled with lack of knowledge, as to the aims and objects of the Association. The greatest handicap, however, is undoubtedly the diversity of manufacturers' associations in the industry. In other industries of a highly organised character, the majority of the producing firms are members of a manufacturers' association which undertakes to finance the appropriate research association. In the case of the founding industry, potential members may belong to no association at all or, on the other hand, they may belong to any one of such important bodies as the National Federation of Iron and Steel Manufacturers, National Iron-founding Employers' Federation, Engineering Employers' Federation, Scottish Ironfounders' Association, National Light Castings Association, British Electrical and Allied Manufacturers' Association, etc.

At the present time the Association can only increase its membership by the slow process of individual approach. Its work has now been scrutinised by an independent authority, and the result of that scrutiny is embodied in the report referred to above. Full consideration of such a testimonial can only result in an entirely favourable verdict. Should not the various bodies mentioned give such consideration to the report and see whether they could not give utterance to their opinion, coupled with a recommendation to their members to support the Association?

Further Government assistance for the next five years is, after such a report, practically certain, and we understand that the precise terms are still a matter of negotiation. We hope to be able to communicate these to our readers as soon as they are available.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Pearlitic Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—There are two interesting pages in your issue of the 1st inst. First, in regard to your leading article; as pointed out in my letter published in your issue of July 5, 1923, the *idea* of pearlitic cast iron is not patentable, only the process by which this can be attained.

Unfortunately, under British Patent Law, as it stands, a patent may be granted which cannot be maintained in the Courts, a most unsatisfactory position for all concerned, though exceedingly good for the legal profession.

Pearlitic pig-iron—and therefore cast iron—has been made ever since pig-iron was first manufactured, hence no patent recently taken out can prevent this being continued. Therefore the controversy regarding pearlitic cast iron resolves itself into a question as to whether the Perlit process is superior to all other methods.

(1) Many claims have been made, but we will deal with three only. As to tests, it is a fact that transverse and tensile tests are obtained with and without the pearlitic structure equal or even superior to those by the Perlit process.

(2) In his letter in this week's FOUNDRY TRADES JOURNAL, Mr. James Smeeton claims:—"Castings are produced showing generally no variation in grain size from the outside to the centre," and, apparently for the first time, this is qualified by: "Or in extreme cases astonishingly little as compared with the ordinary process." In support of the first part of this claim, at Mr. Smeeton's request Mr. A. E. M. Rae Smith, in his article in your journal, gives the result of his investigation, but unfortunately this is only proof for the particular casting he had under consideration, and for those of similar thickness.

Claims, however, are stated to have been made on behalf of the Perlit Company that this close grain size obtained by the Perlit process would apply to cast iron propellers, which is against all practical experience. Over 50 years ago the late Sir Isaac Lowthian Bell proved that even white pig-iron, when cast into a block, was grey in the centre, when broken, and in 1906 I published confirmatory evidence.

With regard to small grain size, both virgin and refined pig-irons are being made to-day cast into a section 4 in. by 4 in., which shows small grain size throughout the fracture; this is a proof that small grain size is regularly obtained without the aid of the Perlit process. Mr. Smeeton's modifications of his first claim suggests that they have discovered the Perlit process would not produce close-grained iron in the centre of a heavy propeller casting.

(3) The third claim appears to be made by figure 3 of Mr. Smeeton's letter. Graphs 1, 2 and 3 of that figure would appear to claim that to secure a balance between T.C. and Si, if the T.C. is lowered by 0.10 per cent., it is only necessary to increase the Si by 0.10 per cent., which conclusively proves that these graphs are purely empirical, and are intended to show that if the T.C. is reduced by "X" the Si must be increased by "Y," which is not strictly in accordance with the graphs.

Again, in 1906 I gave a photograph of a virgin hematite pig-iron analysing *T.C.* 3.28 *per cent. and Si* 0.35 *per cent.* (S 0.026 per cent., P. 0.02 per cent., Mn. 0.07 per cent.), which fracture is still in my possession, but the analyses of the iron would not conform to the graphs in Fig. 3. It is also a fact that there are made regularly pig-irons of T.C. and Si. contents within the limits of the graphs in Fig. 3, which pig-irons when melted and cast into sand moulds would be grey without the aid of the Perlit process.

To put the question of pearlitic structure by the Perlit process into a nutshell, the essential things required are primarily fracture of pig-iron to be used and the C.C. contents of the casting whether these are obtained by the Perlit process or by direct cast iron. Given these two conditions, the ratio of T.C. and Si. to each other may vary slightly, *i.e.*, there is no constant ratio to obtain this structure.

The practical man is not interested in academic discussions, and this letter is therefore confined to facts known to the writer personally.

As stated in my previous letter of two years ago, a Diesel engine piston head made before the Perlit process was known even in the country of its birth, showed a pearlitic structure throughout the headpiece, not only on the surfaces but 3¼ ins. into the section, and of an even grain size.—Yours, etc.,

E. ADAMSON.

18, York Street, Sheffield.
July 2, 1926.

Book Review.

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. Published by Kelly's Directories, Limited, 186, Strand, London, W.C.2. Price 64s., post free.

These and companion directories jacketted in their well-known red covers are a familiar sight in most important offices. Unfortunately, many people forget that a directory which is not up to date is often worse than useless, as it is capable of causing the spending of time, energy and money on the very things which a directory is designed to save. If proof of this be needed, it can be supplied by the publishers of these volumes in the form of an illustration showing that the alterations on one typical sheet amount to 50 per cent. In the 5,000 pages which go to make up this work it is obvious that amongst 1,500,000 business houses listed throughout the world the number which have had to be thoroughly revised and corrected is enormous.

The scheme has been to divide the work into two volumes, the first one of which deals with foreign countries and their possessions, and the second with Great Britain, India and British Dominions, Colonies, Protectorates and Dependencies. Each section is divided into alphabetical, classified trades, telegraphic addresses, exporters and importers. We have nothing but praise for the utility and arrangement of this directory, which should find a place in every office where anything but a purely local business is carried out.

Laboratory Sand Mixer.

A laboratory size Simpson intensive sand mixer is being marketed by the National Engineering Company, Chicago. It is built along the same lines as the larger size used for preparation of core, facing and backing sand. This mixer is intended to be of great help to those interested in sand preparation, reclamation and control, as the results obtained in the laboratory with the small mixer can be put into practice by the use of the larger-sized mixers in the foundry.

The machine is sold complete with motor, weighs approximately 400 lbs., will mix a batch of from 8 to 15 lbs. of sand, and is so designed that it can be taken apart and cleaned in a few minutes. The overall length, including motor, is 34 in.; width, 20 in., and height 20.5 in. The British manufacturing rights for the Simpson machine are held by Augusts Muffle Furnaces of Halifax.

German Furnace Company's American Expansion.

The International Furnace Company, recently incorporated under the laws of Pennsylvania, with offices in the Keenan Building, Pittsburgh, is an affiliation of Ofenbau-Gesellschaft m.b.H., Düsseldorf, Germany, and George J. Hagan, Pittsburgh. The German Company has made numerous installations of industrial recuperative furnaces in large iron and steel plants in Europe, but has taken contracts also in America, including some from a large Youngstown district steel company.

Quality in Quantities.*

By Arnold Lenz, Saginaw Products Company, Saginaw, Mich., U.S.A.

[American Exchange Paper.]

(*Continued from page* 485.)

Pattern Equipment.

Since the machine shop does not check for dimensions before setting the casting for the first operation, there is need of very close checking at the foundry. The most satisfactory way to meet this condition is to guarantee certain locating points by which the castings are set into the machine. This gives the foundry a chance to build a similar fixture in which, by means of templates, slight variations can be adjusted at the locating points and greater variations can be rejected before the castings leave the foundry. In malleable iron, where the annealing may cause some warping, the castings can be run through heavy power presses which make them practically perfect as far as dimensions are concerned, but in grey iron these specifications have to be met without such recourse.

The first requisite in meeting these specifications is good pattern equipment, and a great amount of study and attention to details is required successfully to build a pattern and corebox equipment for complicated automobile castings.

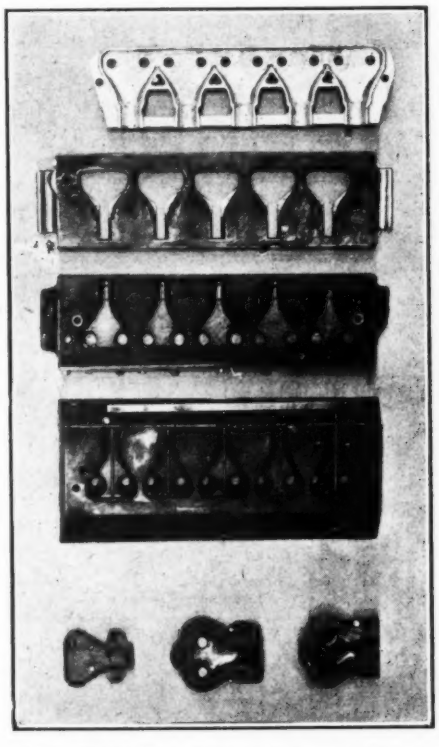

FIG. 8.—A SINGLE CORE BOX FOR BENCH WORK (LOWER), AND A MULTIPLE BOX FOR A ROLL-OVER MACHINE FOR THE PRODUCTION OF THE SAME CORE.

In order to avoid delays and losses, not only in the foundry but in the machine shop as well, every item related to the production of a particular casting should be carefully planned and fully considered beforehand. In a production foundry this reaches far beyond the immediate pattern and corebox equipment, because it is necessary that machines and handling equipment be definitely located and the flow of the material through the plant be routed in advance.

A well-equipped pattern shop is a definite necessity, especially where intricate castings are made, and tool equipment for both wood and metal should include the latest machines developed for this purpose.

Some of the latest additions in labour-saving machines for pattern shops are the high-speed punches for making templates, filing machines, horizontal grinders with magnetic tables for grinding driers, and the automatic profiling machine. The profiling machine is proving especially valuable in the production of duplicate patterns and core boxes, because any number of patterns or core boxes can be accurately reproduced from either wood or metal models. Stripping plates and similar pieces can be produced from sheet metal templates at a great saving of labour. Fig. 3 shows a profiling machine producing a gang core-box from a single model.

Due to the excessive wear, metal is the only practical material for production patterns and core boxes. Double-face match-plates, and also some of the larger patterns and coreboxes, are made of aluminium. For small-gated patterns brass is the standard material, on account of the ease with which it can be soldered. For large patterns, and where great accuracy has to be maintained over a long period, cast iron is the most satisfactory material, and is therefore used whenever possible.

The double-face aluminium match-plate with vibrators is extensively used for small castings that have to be run intermittently, because the changing from one plate to the other is very easily accomplished, and it can be used on either a bench or a machine. They are usually used in connection with snap flasks and steel bands, or slip boxes. Very true castings can be produced by this method, because the plates are centred by the flask pins, and can therefore be rapped only by means of a vibrator, which affects the dimensions of the castings very little. The match-plate adapts itself to either ramming on a bench or a hand or power squeezer.

For greater quantities the so-called split pattern-plate is to be preferred. By this method the cope and drag are mounted on separate machines, and the combination jolt-squeeze stripping type of machine is the fastest for this purpose. The first, or match-plate method, requires a moulder of considerable training, while the second method can be successfully performed by labourers of average intelligence who are willing to exert themselves beyond the requirements of ordinary labour.

The cope and drag moulds of larger castings are always made from two separate plates, which are mounted on either a jolt roll-over or a jolt squeeze stripping machine. This practice has become standard, although quite a number of sand-slingers are being successfully used.

For accurate results, production patterns should be machined all over. Where stripping plates are used, they should be carefully fitted, and to assure a minimum of wear on the pattern and stripping plate, also to guard against inaccuracy through worn machines, the stripping plate should be provided with heavy guide pins which move in hardened bushings in the pattern plate.

Flask Equipment.

The flask equipment plays an important rôle in quantity production, and has a great influence on the quality of the castings. The flasks should be made of metal, have machined joints and accurately fitted closing pins. Flask bars should be designed so as to eliminate tucking of sand under the bars and setting of gaggers and nails.

There are definite rules which can be followed in designing a flask for production work, and there are few jobs in which gaggers and nails cannot be eliminated if these rules are followed. For instance, the moulding of a certain cylinder block required 78 gaggers and 42 nails, but by redesigning the flask, all of these were eliminated with the exception of eight nails. Since it also

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*A Paper read before the London Convention of the Institute of British Foundrymen.

eliminated the tucking of sand under the bars, it can easily be seen that the ramming of the mould was reduced to a very simple operation, which could be done by any intelligent labourer. Special attention is necessary where hot flasks are rammed on jolt machines, and thoroughly tried rules for barring were described in a Paper * prepared by the author for the 1923 Convention of the American Foundrymen's Association. Fig. 4 illustrates some of the rules mentioned in that Paper.

Floor and Conveyor Moulding.

Aside from the machine, flask and pattern equipment, there are several methods of producing castings in the foundry. The moulds may be made and set on the floor during the morning and early part of the afternoon and shaken out by a night gang, who also prepare the sand for the next day.

If continuous pouring is practised, the moulds are usually poured by a pouring gang as fast as they are produced and shaken out as soon as they have sufficiently cooled. This method requires only from twenty-five to fifty per cent. of the flask equipment of the first method and reduces the required floor space by about fifty per cent. This reduced floor space can again be cut in two by the use of gravity conveyors, as arranged in Fig. 5. This has also the advantage over the second method in that it removes the pouring and shaking out from the immediate vicinity of the moulders, giving them better working conditions and the foundry a more orderly appearance.

The latest development in green sand moulding equipment is the power conveyor, which conveys the moulds through the various operations, starting at the drag machines and ending at the shake out. This same system also delivers the sand to a central tempering unit, from where it is returned to bins over the moulding machines. One such unit produces 2,100 cylinder castings weighing 126 lbs. each in nine hours, with a crew of eighty men, or 26 cylinder blocks per man, on a floor space of 260 ft. by 40 ft., including the necessary gangway and sufficient space for the storing of cores; while a smaller size produces 2,300 cylinder heads on a floor space of 120 ft. by 40 ft. Figs. 6 and 7 show two such units.

In the production of medium-sized castings the new sand and coal dust are added into the system so that no special facing sand is needed over the pattern. The same may be done on larger castings, but due to the cutting action of the metal or the burning in at some small projections a small amount of special facing may be used at certain points.

In moulding a casting of the nature of a cylinder block on a conveyor, the operations are very closely divided. Each moulding machine is usually manned by a rammer, labourer and a finisher. The first two produce the mould and the finisher patches or corrects any imperfections, wetting the core prints, dusting and brushing the graphite, and setting the mould on the conveyor. There may be a number of core setters, each one setting one or more cores, while the gauging of the cores may be done by a man stationed at the end of the core setting line. After the copes are set on, the operations are further divided into clamping, moulding of a pouring basin, setting of the pouring basin, pouring, taking off of the clamps and removing the pouring basins. On the shake out end the operations call for removing and shaking the cope, taking out the casting and loading it, shaking out the drag, removing the bottom board and placing bottom board, drag and cope flask on the conveyor to be returned to the moulders. All these operations must be well timed, because congestion at any one point would hold up the whole line.

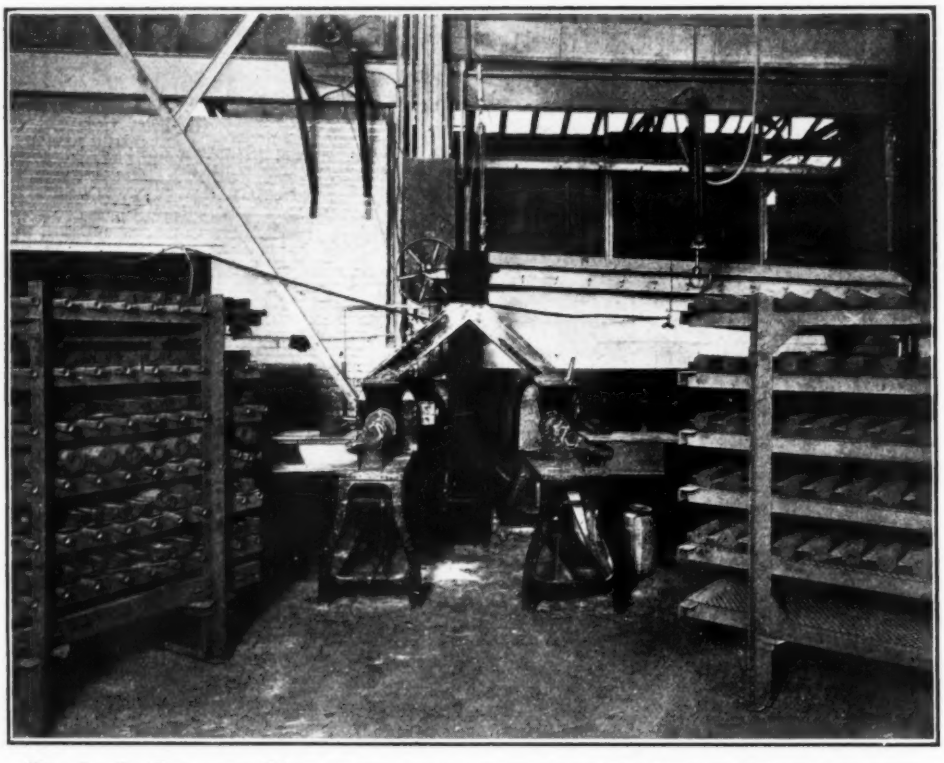


FIG. 9.—AN EXTRUDING MACHINE FOR THE PRODUCTION OF TWO SIZES OF CYLINDRICAL CORES.

Core Department.

In some of the production foundries, especially in those producing automobile castings, the core department occupies an important place, and its force may exceed that of the foundry. A cylinder block, for example, may require as high as fifty or more separate cores, which, if stored in large quantities, would take up a prohibitive amount of floor space. To avoid this the cores are produced only far enough in advance to get them to the foundry in time to set into the moulds. Since at the end of the day there may not be one hour's supply in the core-room, expert routing through the various operations is required. To insure accurate records and

* Lenz, A. "Flask Equipment for Moulding Machines Transactions," A.F.A. vol. 30, pp. 726-740, 1923.

balanced stock, all defective cores, found either in the core-room or foundry, must be turned over to a department created for the purpose.

Due to the intricate nature of the cores and the necessity of holding them to close dimensions, a core department of this nature requires the best of core box and machine equipment, besides a great number of gauges and fixtures. For best results, all cores should be made on machines whenever possible, and many ingenious core boxes and devices have been developed to make this possible. If small cores are arranged in gangs and mounted on machines, not only greater accuracy is possible, but production can be materially increased.

Fig. 8 shows a single box for bench work and a multiple box for a roll-over machine of one of the more difficult cores. The production in this instance compares with 500 to 600 cores on a bench, against 1,000 to 1,200 on a machine, both made by a girl in a nine-hour day.

FIG. 10.—A VIEW OF A PRODUCTION CORE ROOM IN WHICH ALL CORES ARE MACHINE MOULDED.

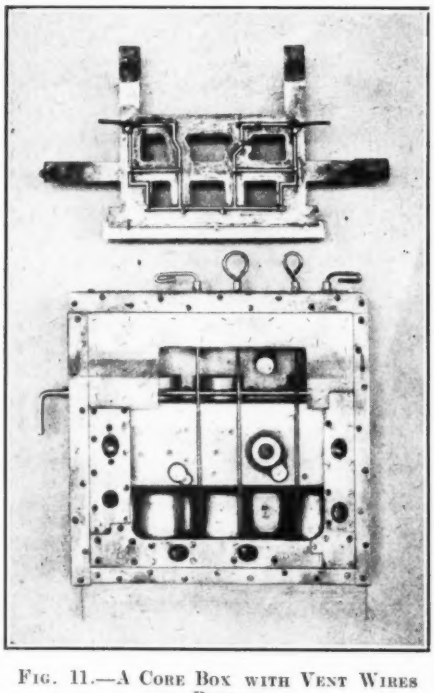


FIG. 11.—A CORE BOX WITH VENT WIRES IN POSITION.

Fig. 9 shows an extruding machine producing two sizes of plain cylinder cores. These cores can be made on a bench from a split box, rammed with a stick and rolled on a plate at a daily production of 400 cores, or the cores may be rammed in a split box on a small jolt machine and placed on driers, at a production of 580 per day per man. If extruded on a machine, cut to the proper length by means of a wire-cutting attachment and removed on driers, the production will increase to 2,700 cores of each size per day for six men. In each instance the quality of the cores improves with the increase in production. Fig. 10 is a view of a section of a production core-room, in which all cores are made on machines, either in single or multiple core boxes.

The operations involved in making a core should be reduced to the simplest form and follow a standard practice. The wiring and venting must be determined and definitely located, or indicated, in the core box, so that uniformity may be assured.

The best results are obtained if the venting is done by means of wires which are placed in the core box before it is filled with sand, and withdrawn after ramming. This method produces clean, positive vents, which can be checked by probing with wires. To prevent the iron from entering the vent system all outside openings not needed in passing the vent from one core to another, or leading the gases out through the mould, are carefully closed with a paste made of graphite or soapstone. Fig. 11 shows a core box with vent wires in position.

To speed up production and to insure against changes in the method of wiring, all core wires are cut and formed before they reach the coremaker. The forming is done in a separate department, which is usually equipped with automatic wire cutting and forming machines, or where only small quantities are required, the bending may be done quite accurately and

efficiently with hand-operated forming dies. The importance of the above can be more appreciated if it is realised that a foundry producing about four hundred tons of auto castings per day consumes approximately 500,000 core wires.

In the production of accurate cores at high speed in large quantities, metal core driers are essential because bedding of cores slows up the operation, produces a rough surface, and unless done by an expert, destroys the necessary accuracy required in quality work. With the employment of modern machines, experience, and a thorough knowledge of the shrinkage or contraction of the metals to be employed, also the necessary clearances, these driers can be built very cheaply.

The assembling of cores, before they are delivered to the foundry, commands a great deal of attention, especially if they are to be used on conveyors where each core must be a perfect fit. The old method, fitting by rubbing two cores together, is a thing of the past. To ensure accuracy, all joints are ground on surface grinders before pasting, and if the bores of cylinder water jackets are split on the centre line of the cylinder they are bored out on special grinding machines, which will remove all irregularities. This also establishes a definite centre line and removes all possibilities of an uneven wall thickness. Fig. 12 shows some of these grinders. Whenever possible, large core assemblies are put together on progressive lines, and Fig. 13 illustrates such an arrangement, in which the cores are moved along the line by means of gravity conveyors.

In any automobile foundry, practically all of this work can be done by girls, because the pieces that are beyond their weight limit are moved along on gravity conveyors. All assembly jigs into which the cores are assembled are accurate duplicates of the mould, and every bearing surface is lined with hardened steel, which can be easily replaced. Since the locating points correspond to the core prints and chaplets in the mould, there is very little trouble in the foundry from crushes or bad fits, and the moulders are therefore not permitted to file or otherwise fit a core.

Cleaning Quality Castings.

Along with closer dimensions and better metal has also come the demand for better appearances and absolute freedom from sand and scale. The tumbling mill, which has served so well in producing the much-desired burnished appearance, is no longer adequate, because it is not always possible nor practical to remove fused sand and scale from small depressions and corners. High-grade castings coming into contact with the oil of the lubricating system must therefore be sand blasted, or sand blasted and tumbled. Such castings must also be delivered free from rust, which is quite contrary to the theory of seasoning in the weather of a few years ago. Since the cost of sand blasting, like that of many other operations, was just another item that had to be absorbed by the foundrymen, they were forced to find more economical methods. The continuous sand blast room, through which the larger castings are carried on chain conveyors, and the continuous sand blast mill, which receives and ejects smaller castings in a continuous stream, are now performing this operation at a fraction of the former cost.

A few years ago practically all cylinders and similar castings were chipped with air hammers. With the increasing demand for this type of castings came also a shortage of high-grade chippers, which even high wages could not overcome. Electric swing grinders and small air grinders, which are easy to operate, were finally pressed into service, with the result that they have practically replaced the air chippers and improved the quality of work at a considerable reduction in cost.

FIG. 12.—SURFACE GRINDING AND BORING MACHINE FOR CYLINDER WATER JACKET CORES.

Inspection and Control.

To control the losses incident to high-quality intricate castings requires constant checking, and a well-organised and well-equipped inspection department is a definite necessity. Unless defects are located, and promptly and accurately reported, the losses can assume disastrous proportions. This is especially true when castings are stored in large quantities by the consumer, in which case the foundry should insist that a certain number be machined on the arrival of each shipment. This will protect both producer and consumer.

On many castings it is necessary to build elaborate checking fixtures into which the castings can be set and the finishes inscribed with hardened steel points moving in hardened and ground bushings. On others, where visual inspec-

tion is inadequate, the checking can be done by means of gauges and templates.

A definite understanding should be had with the machine shop as to the extent of the foundry's responsibility, especially as applied to cracked castings. Harmonious relations can easily be maintained if, in addition to this, a capable representative of the foundry receives and inspects all rejected material at the machine shops and means are provided definitely to check disputes over lack of stock or errors in machining.

There is a growing tendency in progressive manufacturing institutions to operate with a minimum stock of raw materials, and plants which a few years ago carried a sixty and ninety day surplus, and in some cases contracted for six months in advance, now operate successfully on a two to three weeks' basis, which at times may be reduced to even a shorter period. In a foundry producing castings under this condition, the work in process and the finished castings on hand may not exceed one day's production in the foundry. If, in addition, the shipments must synchronise with the daily production of the consumer, the scheduling of output and shipments must receive special attention.

Removal of Refuse.

The disposition of refuse in a large foundry is a considerable item and various means have been devised, such as belt and pan conveyors which take the refuse from hoppers placed beneath the floor line, from which the sand is raised to storage bins by means of bucket elevators. If the bins are placed across the railroad tracks, or arranged so that trucks, tramrails, monorails, cableways, or other means of conveyance can be placed directly under the hoppers, the sand can be removed very cheaply.

Perhaps the most economical and novel installation for removal of refuse is in operation in one of the foundries under the management of the author. In this case the sand is removed from the castings in a room situated between the foundry and the cleaning department, passed through floor hoppers on to a belt, one end of which is equipped with a magnetic pulley which removes the iron from the sand. The belt feeds the sand into a crusher, which pulverises all included cores and discharges into a tank of water from where a centrifugal pump removes the mixture of sand and water and conveys it, by means of a pipe line, to a swamp located back of the foundry. Since the water used for plant purposes is taken from a river bordering on this swampy area, the cost of transportation reduces itself to the power of running the pumps and the investment in the pumps and pipe line.

Since this refuse consists almost entirely of burned core and moulding sand, and is deposited clean and well pulverised, there is a possibility of reclaiming it, because, from all appearances, the oil in the core sand is weathering out very rapidly.

Application of Handling Equipment.

According to an analysis* of Mr. Sklovsky, of Messrs. Deere & Company, the handling of 168 tons of material is required to produce one ton of good castings in the ordinary foundry. Since, in most foundries, handling of material is still done by laborious hand methods, it is safe to predict that the greatest development in the foundry industry in the next decade will be in reducing the handling of materials to a more mechanical basis. A great deal has already been accomplished in this direction, but as in other labour-saving devices, the adoption of existing and the development of new means for this purpose has been largely confined to the production foundry.

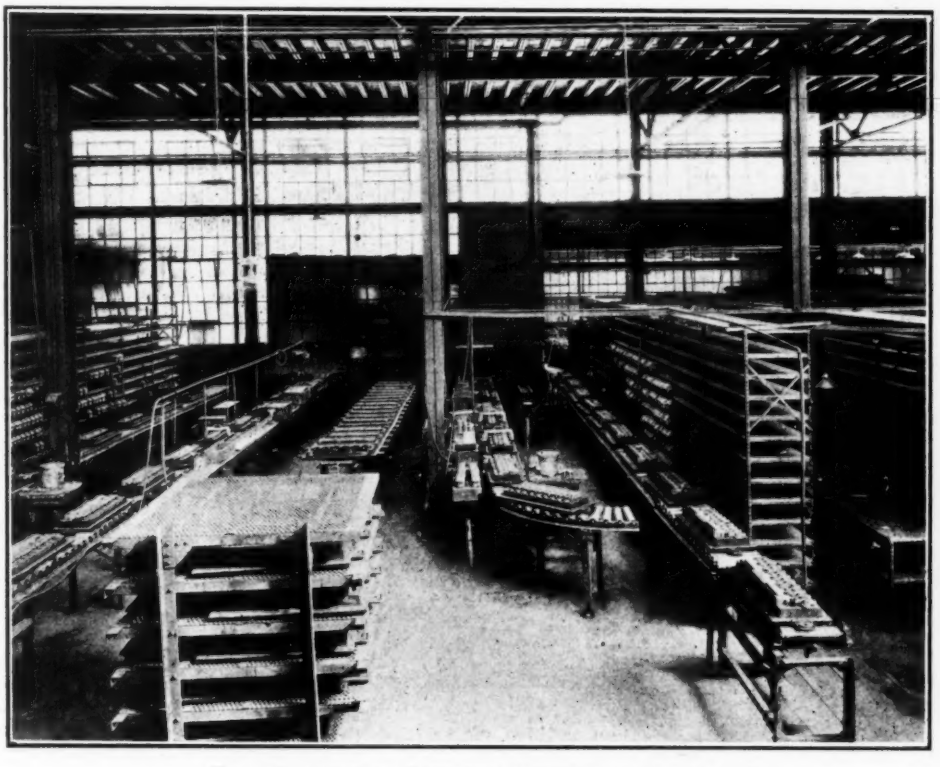


FIG. 13.—GRAVITY CONVEYOR INSTALLED IN CORE SHOP.

How one development may lead to another is well illustrated by an instance that happened in a malleable foundry with which the author is identified. Practically all the high-grade malleable iron produced in America is melted in the air furnace, which does not adapt itself to continuous pouring unless a number of furnaces are arranged so that one of them is always ready for pouring. This has prevented the malleable-iron industry from taking advantage of the benefits derived from putting the foundries on a continuous production basis. Knowing definitely the savings that could be affected by more modern methods, thoughts were turned toward the development of some melting process that would make this saving possible. This has now resulted in a new cupola-electric furnace process which not only meets, but exceeds the specifications for high-

* "The Foundry" April 15, 1921.

grade malleable iron. It has made possible the building of a series of mould, sand-handling, and casting conveyors, and, together with continuous mills and continuous annealing ovens, marks a definite step forward in the production of malleable-iron castings.

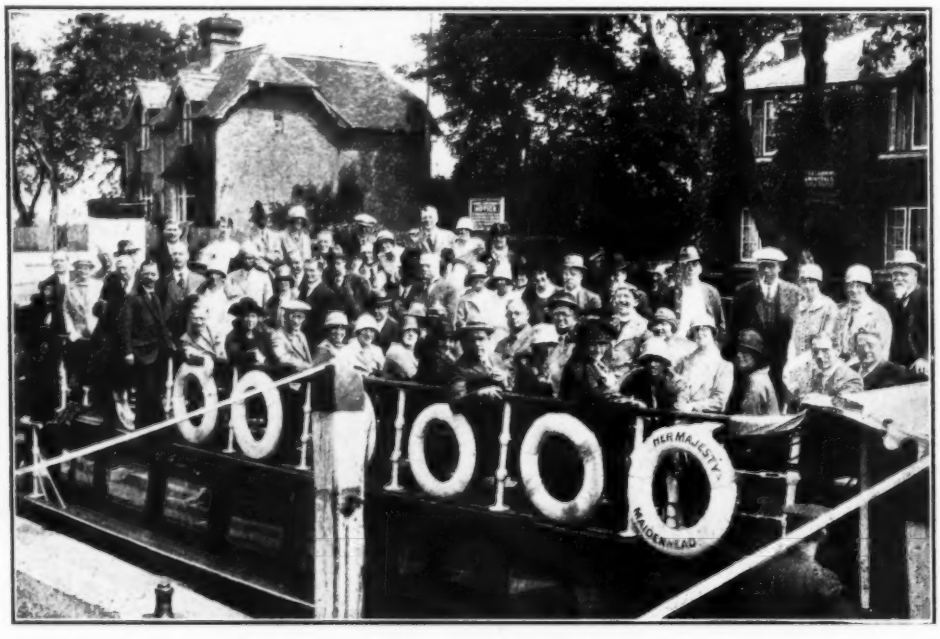
It might be of interest to point out a few of the performances achieved by the application of labour-saving devices. By means of a crane and magnet it is possible to move all incoming pig-iron and steel scrap from cars to stock piles, and at the same time supply the charging deck with all the iron, including foundry returns and limestone required for a 600-ton melt, with four men. By the use of mechanical sand-conditioning and distributing equipment, two men are conditioning and distributing approximately 400 tons of moulding sand every nine hours. In addition to the large output per man-hour, the sand is cleaned of all iron and has a texture and uniformity of bond and moisture that cannot be consistently reproduced on the floor even by the best moulders. On a conveyor, one man sets 4,200 cores weighing 45 lbs., and six men pour 160 tons of iron into 2,100 castings.

Great savings are possible by the use of electric lift trucks for moving platforms on which material is loaded, and electric and gasoline trucks and tractors. The most efficient means of transportation, however, is found in the application of conveyors, and the tendency in the production foundry to adjust its principles, but having spent his early life and received his early training on the Continent of Europe, he knows that there is a great deal of room, if not an actual need, for more specialisation and the economical benefits derived from the application of the principles of quantity production.

In concluding, the author wishes to state that his convictions in regard to the production of quality castings in quantities is based on a varied experience in both jobbing and production foundries, as practical moulder, core maker, melter, foreman, superintendent and manager. He recalls not a single instance where the application of quantity-production has not improved the quality of the product, improved the status of the workmen and resulted in great benefits to the producer as well as to the consumer. He is a great believer in the exchange of ideas among manufacturers and competition by individual efficiency. His belief is perhaps strengthened through his close contact with the automobile industry, which has immensely benefited by practising this policy in the most liberal manner. He realises that the great consumption and distributing facility of the United States, within its own borders, presents a condition especially favourable to the application of these manufacturing methods to this type of transportation is growing with every year. The specialty foundry producing such castings as pipe, carwheels, radiators, fittings, etc., has the advantage in this respect, and it will only be a matter of a short time until the more progressive of them will have a continuous flow from raw material to the finished product. The foundry producing a greater variety and more intricate castings will find a combination of the continuous and intermittent type of equipment the most economical, especially in the application of continuous core ovens, core delivery, and cleaning-room equipment.

River Trip on the Thames.

The grand finale of the Convention took place on Saturday, June 19, when members and visitors enjoyed a river trip by launch along the Thames. In spite of the doubt which had existed until almost the eleventh hour as to whether or not, owing to the emergency regulations resulting from the coal strike, the arrangements made for the excursion would stand, and also the fact that some slight alterations had to be made in the original programme, the day was most enjoyably spent, and the excursion was a fitting end to the Convention, particularly in view of the almost unique opportunities it afforded for social intercourse, upon which the Institute has always placed due value. We were favoured with brilliant weather, a factor which goes so far to make or mar the success of such a function.



A GROUP TAKEN DURING THE RIVER TRIP.

The party entrained at Paddington in the morning, special compartments being reserved, and reached Staines at about 11 a.m. Here they embarked on the launch *Her Majesty* and made for Windsor, enjoying the scenery, riverside mansions, bungalows, etc., *en route*. On the way to Windsor they passed Runnymede and Magna Charta Island, where King John signed the famous Charter in 1215.

A halt was made at Windsor, and the party disembarked for luncheon at the Bridge House Hotel, on the Eton side of the river.

Little time was devoted to speech-making after luncheon, but the President, in the course of a few remarks, again expressed the gratitude of the whole party to Mr. H. G. Sommerfield, the Hon. Convention Secretary, for the excellent arrangements he had made on their behalf, and regretted

that Mr. Sommerfield himself was unable to be present.

It had been the intention originally to spend two hours in Windsor, in order to give the party the opportunity of inspecting the Castle and the many other historic buildings in the town. It was then the intention to continue up river via Bray, Maidenhead, Boulter's Lock, Cliveden Woods and Cookham to Bourne End, and thence by special train back to Paddington. The coal strike regulations, however, were responsible for an alteration. Actually the party re-embarked immediately after lunch at Windsor and travelled up stream via Boveney and Bray to Taplow Bridge, from whence a return was made to Windsor. The scenery along the river was delightful, and included Eton College, Bray Vicarage and Church, as well as numerous bungalows and mansions. There were one or two "side-shows" which attracted considerable attention, one being a glimpse of the racing at Windsor racecourse. Tea was served on board during the journey.

On arrival at Windsor there was an hour to spare, and most of the party visited Windsor Castle, the Long Walk in Windsor Park, etc. At 7 p.m. the party entrained for Paddington, again in reserve compartments, reaching Paddington at 8.30 p.m. It was here that the farewells were exchanged, and some considerable time elapsed before the last of the party had left.

Discussion on Convention Papers.

Mr. E. J. Yates' Paper on "Some Notes on the Production of Cylinder Pig-Iron to Fracture and Analysis."

MR. J. SHAW (Sheffield) said that while he had always held the view that the ordinary analysis was not always a key to the physical properties of the iron, he must protest against the misleading statements of the author, while quoting one (silicon) constituent only. A glance at the content of the open and white samples gave an immediate explanation. To compare irons which in one case contained T.C. 3.68, Mn 2.11 and S 0.046 per cent., with another that contained T.C. 2.49, Mn 0.37 and S 0.32 per cent. simply because the Si was roughly 2.13 per cent. in each case was futile. The relation of the Mn to the S was quite as vital as silicon on their effect on the structure. The question of FeS had been mentioned in the Paper later on, and he (the speaker) would be pleased to learn if the author had ever identified FeS in cast iron even when the S was in excess of the Mn. This had been done in steel, but so far he (Mr. Shaw) had met no one who had seen it in ordinary grey iron. He was quite in agreement that some standard method of sampling should be devised, but what was of much more importance to the ironfounder was that the furnaceman should keep his casts separate and not fill an order from two or three casts. Recently four pigs were taken from a wagon and a certain mixture for some experimental work based on the figures obtained. On completion it was found that the Mn was just double that obtained from the four pigs sampled and the whole of the work was wasted. He had not been alongside a blast furnace for 15 years without some knowledge of the difficulties of the blast furnace manager, and he thought if he would submit separate casts that did not quite meet the specification, most foundrymen would be willing to consider them and help him. Mixed casts could only lead to loss of custom.

MR. H. FIELD said there were two points in the Paper which called for attention. One had reference to the varying content of manganese in the so-called high-manganese pig-iron. He gathered that the North Staffordshire pig-irons—and he referred to these in the general sense—were in demand particularly because of their high manganese content. To the Midland ironfounders they were often exceedingly useful, but only in so far as their high manganese content was maintained, and he voiced the complaint, therefore, to the makers of these high-manganese irons, that the manganese content was most unreliable. During the last five or six years he had been all round the North Staffordshire furnaces in an endeavour to obtain abundant supplies of manganese irons containing always over 1.5 per cent., and often over 2 per cent. manganese—according to the makers. For his own purposes he had prepared a graph showing the variations in pig-iron, and in the present year the manganese content had varied from 0.6 to 2.9 per cent. in the North Staffordshire high-manganese pig-iron. It must be more reliable if it were to retain its reputation. Dealing with physical properties, he asked Mr. Yates whether he really had evidence that when two irons, of similar analysis but of different fracture, were cupola melted, they possessed different physical properties. Was the structure of iron maintained with equal conditions in the cupola?

MR. COLIN GRESTY (Newcastle) said he had found difficulty in understanding the contradictory statements in the Paper with regard to analysis and fracture. First it appeared to be the author's view that fracture and analysis must go together, but later he suggested that one of these was useless. It was difficult to know exactly what was meant, but it appeared to him that the author had made out a very good case for analysis only, and had proved that fracture did not matter. However, he asked for more direct evidence on the point. The question was wrapped up with that of whether there was any difference in the properties when re-melted of two irons of the same analysis but different fracture. He himself had never discovered any difference, and at the works where he was engaged they had never, during the last fifteen years, to his knowledge, paid attention to the fracture of any pig-iron, but had worked entirely to analysis. Consequently, he did not think there was a great deal in fracture. To the blast furnace manager or blast furnace chemist, who knew the conditions of the furnace, the fracture might be a guide in manufacture, but it appeared to be of little importance to the user. A statement made by Mr. Yates, in the Paper, that the size of graphite flakes bears a very close relationship to both the total carbon and combined carbon, irrespective of the other constituents, appeared to be somewhat ambiguous. He asked, therefore, for a definite statement as to that relationship, and whether it was really irrespective of the other constituents, because in other parts of the Paper it would appear that silicon was the vital constituent.

MR. F. J. COOK (Past-President) disagreed with Mr. Gresty's point that it was sufficient to work to analysis alone, and said he thought that Hailstone and himself had broken that idea down some years ago, when they obtained irons, the chemical analyses of which were so near as to be almost unbelievable, the physical properties of the castings produced varied widely. Therefore, they concluded that there must be some relation between fracture and analysis, and he considered it dangerous to suggest that satisfactory results could be obtained by working to analysis alone. If, for instance, he were given an iron with an analysis which he considered to be satisfactory, but on examination of the fracture he found it was white iron, whereas he wanted a thin grey-iron casting, he would not accept it.

MR. W. JOLLEY congratulated the author upon having contributed the Paper, and assured him that there was no need to be despondent as the result of the adverse criticisms made. It was far better to do something which aroused criticism than to do nothing at all; indeed, it had been said that the man who never did anything wrong never did anything at all. He believed that the best method of testing pig-iron was to analyse it, and then to follow up the daily casts by using the Keeps method. Fracture also must be taken into consideration; otherwise one would sometimes produce castings which, though in every way correct according to analysis, would fail physically.

MR. N. D. RIDSDALE (Middlesbrough) supported the author's remarks as to the necessity for a standard method of sampling pig-iron, and considered that that was even more important than a standard method of analysis. A reasonably accurate method of sampling was to drill from the top to the bottom at a point midway between the centre and outside of the inverted pig. One method, which was not too tedious, was to place

a broken piece of pig-iron 6 or 8 in. long in a lathe, where it was held by a chuck, and to take side shavings right across the section with a side shaving tool. The fractured face must first be sawed off level, and then a complete slice could be turned off the pig and the turnings carefully collected while it was revolving in the lathe. This method was much more practicable than the ordinary method of planing. As to the alleged practice of some pig-iron makers, of mixing unsuitable material with casts of suitable material, in order to work off some of the former, he agreed that such a practice was very mischievous, inasmuch as chemists could seldom sample a large number of pigs from each batch.

MR. E. LONGDEN agreed that it was necessary to consider both analysis and fracture. In illustration of this he referred to a heavy casting in No. 4 Derbyshire iron, the boss of which was almost unmachinable, whereas the rim could be machined fairly easily. The analysis had conveyed nothing in that case. He also expressed the view that the orthodox analysis was not sufficient, and that it should be extended to include the gases present in the metal.

MR. A. LOGAN said there was doubt in his mind with regard to the particular pig-irons which were referred to as being on view in the Exhibition, and which both contained silicon in the neighbourhood of 2 per cent. One was a white iron and one an open iron as Mr. Shaw had stated. The analyses of these showed that one contained high sulphur and low total carbon, and the other contained low sulphur and high total carbon. Then he himself believed that that was the explanation as to why one was white and the other open; the whole thing was explained by analysis entirely, in which case the paper was really very misleading. It appeared completely to make out a case for analysis only. He confirmed Mr. Gresty's remarks with regard to working to analysis only, and was of opinion that pig-iron fractures were immaterial. He took exception to the paragraph which stated that "The fracture is a guide to the internal structure of the metal, which is, after all, the main consideration in the finished casting. Re-melting an iron does not destroy its initial structure, though it may be modified due to varying cooling rates."

MR. J. E. FLETCHER, referring to the author's question as to what were the possible permutation and combinations amongst fracture, total carbon, combined carbon, silicon, manganese and phosphorus, said that a consideration of the points mentioned in that question lay at the root of what had been attempted to be said that morning with respect to the influence of either one or two special constituents in cast iron. Though we were getting nearer to the truth gradually, we should realise even now that we knew very little indeed as to the results of these combinations and permutations. That was one of the directions in which any research association or scientific body had to work in connection with cast iron. We had not yet reached the point at which we could say that the manganese-sulphur relationships were the most vital, or that the silicon, total carbon and graphite were the most reliable indices as to what an iron really was. The statement that fracture had nothing to do with the ultimate results in the casting could not, he believed, be verified. There were those who used portions of white iron in their mixtures, giving certain results which were not obtained unless that white iron were used. Such points as that had not yet been solved in any satisfactory sense, and yet we could, after a certain amount of experience, choose our mixtures by chemical analysis and fracture and obtain results in accord with what we might expect. But unless, under such circumstances, we took care to examine the fracture of certain ingredients put into our cupola charges, trouble might occur, and he did not think we could depend entirely upon chemical analysis. He thanked Mr. Yates for having brought this subject forward; it was one which came forward almost every year in one way or another, and many foundrymen, especially those engaged in making the stronger types of iron, were finding already that analysis alone did not provide a sufficient safeguard. He had found, in the course of many years' work, that the structural composition of a cast iron, when worked out, would give some very useful information, but something more was necessary. In addition to the points already mentioned as influencing cast iron, there were questions such as temperature of fusion and melting, mass effect, casting conditions, and the condition of the mould; those were quite sufficient to make one wonder which of them was the most vital in co-relation with the chemical and micrographical analyses as determining the desired properties of a cast iron.

AUTHOR'S REPLY.

MR. YATES replied to the discussion. Dealing with Mr. Shaw's remarks as to individual cast analyses, he said that every hundredweight of pig-iron that was sent out, so far as he had anything to do with it, was supplied out of one individual cast. If there were two individual casts in a consignment, the analyses of both were provided, and no pigs out of one cast could possibly get into another cast except by the merest accident. Each cast was stacked individually, and that meant considerable trouble for the pig-iron producer. One point he had noticed with regard to manganese sulphide was that it would most persistently segregate to the top of an iron, whereas iron sulphide did not show any such tendency.

MR. SHAW asked how he knew that it was iron sulphide.

MR. YATES replied that he appreciated what Mr. Shaw was getting at, but must refer him to the papers on the subject. It was too much for any one man to go into all these points, and we must take so much for granted from other people's experiences.

Replying to Mr. Field, he said that the high manganese content was a characteristic of the North Staffordshire iron, but the variation from 0.6 to 2.9 per cent. was a very wide one, and he would like to know why Mr. Field experiences such a wide variation. In blast-furnace practice, whilst one could not control the manganese content within small limits, one could control it within limits closer than those mentioned, and if Mr. Field cared to put forward a specification of limits which a blast furnace could work to with that particular product, no doubt he would find that he would get the material he wanted.

With regard to the different physical properties of irons with different fractures, on re-melting, he said that iron was supplied both to analysis and fracture, and in a good many cases even to-day it was supplied to fracture alone; the users did not seem to bother about analysis so long as the fracture was given. He would be glad to meet Mr. Gresty at some time when he was buying pig-iron, because it was very much easier for pig-iron producers to supply to analysis only than to supply to analysis and fracture.

The PRESIDENT asked if both analysis and fracture were specified in any case.

MR. YATES replied that analysis and fracture were specified in 50 per cent. of the cases. The various fractures were shown on the stand, and they represented the ordinary shades to which the iron was graded. Some buyers asked for one particular fracture, some would give the alternative of one or two, whilst some asked that the iron should not be too close or too open. The fracture was important in 50 per cent. of the cases, and if the fracture were not of the type usually received the producers usually heard about it very quickly.

Replying to Mr. Gresty's question as to the relationship of the graphite flakes to the total carbon and combined carbon, he said that the size of the graphite flakes made a distinct difference in the ordinary way between the fracture of a No. 1 Cleveland and the ordinary No. 4, and it was well known that the combined carbon rose progressively from the more open to the closer fracture. Incidentally, the total carbon fell. The fractures shown on the Cast Iron Research Association's stand illustrated the point with regard to total carbon, although the combined carbons were not given.

In reply to Mr. Ridsdale, he said that what was wanted more than any rigid scientific method of sampling was a method which could be applied conveniently in works to give consistent samples. It should be possible to drill pigs in the same

way and get the same results with the same methods of analysis, and that, after all, was what was wanted in the foundry and blast-furnace plants more than any rigidly scientific method which was going to differentiate between pigs the silicon contents of which varied within very narrow limits. Consistency was the thing that mattered in pig-iron, and if standard methods of sampling and analysis could be arrived at it would ease the situation. Some people, for instance, would drill a hole straight into the face of the pig, some included the skin even in the drillings for analysis, and so on, and that sort of thing caused friction between the blast furnace and the foundry.

With regard to gases in pig-irons, he said that from the blast furnace point of view he could not offer much enlightenment on the point. The whole subject of gases in metals was very vague, and it was just one more of those permutations and combinations mentioned by Mr. Fletcher.

In reply to Mr. Logan, on the question of manganese and sulphur, he said it was a well-recognised rule in blast-furnace practice that the higher the manganese which one could run in the burden, the lower the sulphur over the whole series of fractures. If one had trouble with sulphur in the pig, due to the coke used—and blast-furnace coke was not uniform—the trouble could always be cured by high manganese. So far as his experience went, the same factor operated in the cupola.

Mr. LOGAN said the point was whether the difference in the fracture of the white iron and the open iron was due to the difference in the composition of the two pigs used.

Mr. YATES replied that it was, but the vital point in the production of all those fractures was the temperature of operation of the furnace, which varied from time to time. He agreed that white iron with 2 per cent. silicon was an anomaly, but such anomalies were produced. In blast furnace work one was dependent upon thermal conditions more than upon anything else, and it was that that one had to watch in getting the fracture required.

On the question of abnormal fractures, he said that fracture was no guide when the pig-iron had been subjected to abnormal cooling conditions. Under ordinary conditions, however, where the same cooling conditions prevailed in the pig bench time after time, there were no alterations in fracture. The conditions in ordinary circumstances did vary slightly, as, for instance, between a wet and a dry day, but on the whole such variations did not produce any alterations in the fracture of the pig, and the properties seemed to persist in the metal when re-cast.

M. R. Lemoine's Paper on "The Practical Utilisation of Apparatus for Measuring the Permeability and Cohesion of Moulding Sands."

Mr. W. H. POOLE said there was no doubt that foundrymen would have to pay more attention to sand in the future than they had done in the past. Generally speaking, the condition of the sand did not receive the attention it warranted until some definite trouble arose, and usually there was no system adopted for the maintenance of definite sand conditions. During the last twelve months at his foundry each section had been entirely cleaned up at regular intervals of a month or six weeks, the sand being re-conditioned and put back again. The results were astounding from the point of view of the quality of the casting and the skin obtained, and, incidentally, from the point of view of the saving of sand. It was surprising to him that those responsible for the supply of sand did not pay more attention to grain selection, because the variation in the quality of the sand from the same pit month by month was astonishing. A firm supplying sand would be amply repaid if they made periodical tests with a view to keeping sands in a definite condition, irrespective of whether they were having trouble or not. He mentioned the case of one foundry which, when trying new sand, obtained remarkably good results for the first week or two, but after a month or more the whole condition of the foundry floor altered. By comparing the previous sand conditions to the new sand conditions they had come to a new understanding of how to change the mixtures and keep them in good condition. In connection with steel moulding they made it a practice to test the moisture content of the batches of facing sand all round the foundry, and in green sand steel moulding the number of wasters produced as the result of bad sand conditions was reduced to an absolute minimum by that simple moisture test.

Mr. J. E. FLETCHER (Consultant to the British Cast Iron Research Association) dealt with the questions of the mixing of sands and their permeability. He believed that many sand research workers lost sight of a very practical point concerning sand in a mould. When metal was poured into a mould only a very short interval elapsed before shrinkage began; immediately shrinkage set in, and the metal surface contracted from the mould face—except, of course, where the casting was resting on its base—our ideas about the permeability and conductivity of sands began to be disturbed. Between the metal and the mould there was a space through which cold air was rushing at a speed very much higher than we might perhaps at first imagine. The heat was not taken up by the sand at the rate we often imagined; at the actual contact surfaces at the bottom of a casting the heat was being conducted at one rate, whereas in those parts where the sand had left the casting there was an undoubtedly different rate of heat conduction. He did not think that point had been sufficiently stressed. In many cases he had dealt with, where large steel castings were shrinking to the extent of $\frac{1}{4}$ in. to the 1 ft., and where, in a short time, there was a space of $\frac{1}{4}$ or $\frac{3}{8}$ in. between the sand and the casting, these questions concerning the permeability of sands assumed quite another aspect. After all, however, it was the permeability during the contact of the molten metal and the sand that mattered. While in America last year he had had an interesting conversation with Mr. Dietert, and with Mr. Harrington, his collaborator. They were trying to evolve a gas permeability test on the mould in actual contact with the metal—the apparatus being not unlike that sketched in the Paper—so that the gases could actually be drawn from the face of the mould. The question of the mixing of sand affected the permeability question functionally in a most important way. He had seen sands taken repeatedly from the bottom of a certain measure which had never given trouble, but as soon as he had received deliveries from the same sand pit under certain conditions, sand from the top and the bottom being mixed together, a great deal of trouble was experienced. Referring to the curve in Fig. 1, where M. Lemoine had drawn attention to the permeability of washed sand, he asked if it were possible to give a comparative curve of the same sand before being washed, because he had found such a comparison to be very useful. It was most difficult to get a permeability value which one felt was a practical one, and although the papers which were coming before the Institute in connection with sand were most valuable, it must be remembered that all these workers were dealing with the subject progressively and had not settled anything yet, but they were on the way towards solving some of the most difficult problems in sand research. The British Cast Iron Research Association very much valued every contribution of this sort, because they were a very great help to those who were trying to get some little knowledge of this big subject.

Mr. COLIN GRESTY (Newcastle), referring to Fig. 1, said that the curve gave its permeability of sand heated to different temperatures, but no indication was given of the permeability at normal temperatures. It was to be assumed, apparently, that from the peak at the point A the curve would go down towards the left, but he asked if that could be confirmed, because it rather indicated that from ordinary temperatures up to about 700 deg. the permeability of the sand was gradually increasing.

Mr. HORACE J. YOUNG, F.I.C. (London), was exceedingly glad to hear that the British Cast Iron Research Association were taking up the attitude indicated by Mr. Fletcher. At

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the Glasgow Convention he had got into hot water for pointing out that many tests then being applied to sands were of little practical use so far as he could see, particularly in relation to permeability to gases. There seemed to be a misconception among foundrymen that the gases and the heat from the casting rushed through the sand, but, so far as he had observed, nothing of the kind occurred and in the hot mould process one obtained very much evidence to the contrary. He had observed that about an hour after a large casting had been poured a pyrometer which was placed an inch or so away from the metal had not altered, and he believed that had the hot gases been passing through the sand the pyrometer would have shown it. Actually they came out where there was a vent or joint. He agreed with Mr. Fletcher that we must alter our methods of investigation of sand, particularly on the question of permeability. A core might be permeable, but he did not think the sand outside the casting was permeable except it was thoroughly burned. One factor which had to enter into this investigation was that of conductivity, and it would be found that, while we were now using chills, which were not permeable at all, we should in the future—perhaps after many years—be using sands of different conductivity, which would give the effect of a partial chill at those points where the metal needed to be densest. Therefore, he hoped the British Cast Iron Research Association would investigate sands not only from the permeability point of view, but also from the point of view of conductivity.

MR. J. G. A. SKERL (B.C.I.R.A., Sheffield) pointed to the variables occurring in sands, and urged the necessity for first investigating thoroughly one particular sand, and then gradually to apply the knowledge so obtained to a group of sands. That was the plan adopted by the British Cast Iron Research Association. There were two variables which were most important in the investigation of sands, namely, the degree of ramming and the degree of moisture present. In America and on the Continent, up to the present, ramming had not been taken into such great account as it should have been, and one found that the results obtained by investigators could not be correlated. American methods, which Mons. Lemoine seemed to half advocate, were not suitable for British sands, because the latter were generally of finer grain and stronger. Also fully half the British sands were red sands, which were unknown on the Continent and in America, and which had well-known characteristics of their own. Referring to the reference in the Paper to the need for a knowledge of the behaviour of sand at high temperatures, he said he had done a certain amount of work in that direction, but the difficulty was to maintain the high temperature necessary. He assured Mr. Young that research on conductivity and specific heat of moulding sand was being undertaken.

Mr. Arnold Lenz's Paper on "Quality in Quantities."

MR. E. LONGDEN, discussing the application of handling equipment, pointed to the statement that four men could handle a 600-ton melt, and said that it was very ambiguous. On the face of it, that would be a wonderful performance, and there must be a great deal more behind it. He asked how many men were employed in the handling of the material on the charging platform other than those on the electro magnetic, because it appeared to him that there were a great many more men required for handling and putting into position for the electro-magnets, so that what was gained on the swings might be lost on the roundabouts.

MR. A. HARLEY (Coventry) agreed cordially with the thesis put forward in the Paper, that quantity production did mean quality, and said it was obvious that where every operation was separated in the manner indicated in the Paper, the results must be better than those obtained in the ordinary jobbing foundry. Commenting on the warning given by Mr. Arthur Henderson in welcoming the members and delegates that morning, as to the danger of men becoming merely routine workers, he said the problem was a difficult one. Under modern conditions we could not very well get away from that. At the same time, it must not be ignored by the workmen to-day that there were still fields for the exercise of their intelligence in the design of equipment and in the metallurgical problems associated with foundry work; that while the skill required in moulding and core making was being reduced to a negligible point, there were other problems in the solution of which the brains of the workers could be well exercised. One of the chief problems to-day in large foundries was the handling of material, and he prophesied that in the near future many of the large foundries here would have to adopt mechanical means of conveying material, such as were dealt with in the Paper. The difficulty about adopting quantity production methods in this country was that of disposing of the products made. Recently he had laid out plans for foundry for a very large output, and with every mechanical convenience that could be employed, but was up against market conditions. Such a foundry was definitely dependent upon a selling organisation that would clear the production quickly, but the conditions in this country gave us pause, because it would be disastrous if any hitch occurred either in production or in disposing of the castings produced due to spasmodic demand. There was another side to the picture, however, namely, that such methods certainly reduced costs, and that in itself would probably create the necessary market.

MR. HORACE J. YOUNG, F.I.C. (London), in a denunciation of intensive price cutting, referred to a foundry which was turning out 100 to 120 tons of castings weekly without making a profit. The question would arise in the minds of his hearers whether that foundry made castings at a competitive price, and he could state that the castings in question were manufactured at a cost of 8s. to 10s. per cwt. Something more than economical mass production was involved. In his opinion our foundry troubles in this country were due partly and mainly to the cut-throat trade that existed. There were a number of founders in this country willing to make castings at a loss, thus deliberately ruining the industry. He knew of foundries which could not get work save at a loss, and when a foundry produced castings at less than 10s. per cwt. and yet could not make a profit it proved there was something radically wrong at the core of the foundry trade.

Mr. J. S. Glen Primrose's Paper on "Non-Ferrous Metallography."

DR. H. HYMAN, Ph.D., said that the Paper was of the usual high standard associated with Mr. Primrose. The only criticism he had to make was with reference to the alloys in Table I and the corresponding micro-photographs. In connection with specifications A and B, the Alpha brass was made to give a higher tensile and elongation than the Alpha-beta brass, but that was not in accordance with the general custom. Usually, Alpha-beta brasses gave high tensiles and low elongations and Alpha brasses lower tensiles and correspondingly higher elongations. He asked whether it was not possible that the photograph illustrating the Alpha brass was really a Beta structure. Perhaps the analyses representing classes A and B would help to clear the matter up.

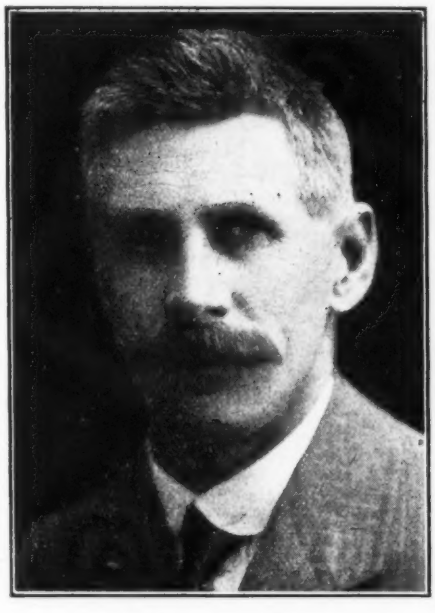
MR. E. LONGDEN, referring to the remarkable micro-photographs showing the effect of the rise of casting temperature, said it would be very illuminating if Mr. Primrose would carry out some experiments on the use of hot moulds. There had been some wonderful results with the Lanz process, and modifications of it in connection with cast iron, but he did not know whether similar results would be obtained with non-ferrous metals.

MR. P. A. RUSSELL thanked the author for the Paper, and particularly for supplying what he had called standard micro-photographs for purposes of comparison. His (Mr. Russell's) firm ran both an iron foundry and a brass foundry, the latter being only a small part of the foundry concern, and they had found the microscope of enormous advantage in investigating the troubles that arose, and which seemed to be even worse in

brass founding than in iron founding, particularly with regard to casting temperatures.

Mr. FLETCHER thanked the author for emphasising the necessity for examining one particular area of a specimen instead of moving about. He himself had adopted that particular practice for 25 years. Some of those who had not had very long experience might benefit greatly by what the author had said, and they all thanked him for his usual wonderfully clear work.

Mr. A. LOGAN said the author had rightly emphasised that very high magnifications were not really required, and that applied to the iron foundry as well as the brass foundry. In the majority of cases it was not necessary, for works practice, to go beyond 150 diameters. The point needed emphasis because the microscope was looked at by some folk with feelings of awe, and some were rather discouraged to adopt the microscope on account of the skill and manipulation required.



MR. J. S. G. PRIMROSE.

(who read a Paper on "Metallurgical Microscopes").

Mr. J. S. Glen Primrose is a graduate of the Royal Technical College, Glasgow, where he was for some years Lecturer in the Metallurgy Department and inaugurated the metallography section. His practical experience, gained in important engineering establishments at home and abroad, is incorporated in several standard text books on metallurgical subjects. He has frequently contributed to the proceedings of the Institute at their conventions and at several of the local branches. Although chiefly engaged upon the ferrous branches of metallurgy, Mr. Primrose's association with his brother on the non-ferrous side of metallurgy has given him a close insight into the practical value of its metallography, to which subject his present paper is devoted.

With regard to the use of screens, mention was made of the K.10 yellow screen as being the most generally useful. He asked if this was a misprint. He was very interested in the author's description of the use of ultra-violet light for high resolving powers. Although ultra-violet light was of very great practical use for pure research work, he was inclined to think that it would be some time before it would come into general use in works practice. There were many difficulties and troubles attendant upon its use. The self-annealing of certain aluminium alloys was also a very interesting point. He believed most types of Alpha-beta structure showed this phenomenon, given suitable conditions. The same thing occurred in connection with alpha-beta manganese brass. In fact, in the production of such castings as propellers automatic annealing of the casting in the mould was purposely arranged.

Mr. N. D. RIDSDALE (Middlesbrough) asked what colour process the author considered to be the best for colour photography through the microscope. He understood that the "Lumiere" process generally gave rather a dense picture, which was too dense if one wanted to use the colour transparency through the lantern for lecture purposes. He asked whether the author had ever used the Paget colour process, and whether he considered it to be more suitable on account of the more transparent picture produced.

MR. WESLEY LAMBERT (London) expressed his appreciation of the paper, and suggested that, being now in possession of this paper, which covered the general ground of the apparatus used in the laboratory in connection with the examination of the microstructure of metals, we should not require any more papers of this kind. This paper should be regarded as a text-book so far as the apparatus is concerned, and what was now wanted was papers dealing with the microstructure of particular foundry alloys. The analysis should be clearly stated, together with the conditions under which the alloy was compounded, the size of the sections from which the pictures were taken, and so on. The specimens to be cut from castings produced both under ideal conditions and improper conditions, and the photomicrographs should be clearly interpreted, so that a student could

M. L. PIEDBOEUF

(who presented a Paper on "High Duty Cast Iron").

M. Piedboeuf is a graduate of the Liège Technical College. He is a prominent member of the Belgian Foundrymen's Association. From 1899 to 1923 he was managing director of the Ateliers Simonon S.A., a malleable cast-iron foundry at Herstal. Since then he has acted as a consulting engineer and representative for the Walter Desulphurising Process. He has contributed many papers on foundry practice to the French and Belgian Societies.

familiarise himself with the micro-constituents and also the defects of any particular foundry alloy. His experience was that the young operator had considerable difficulty in correctly interpreting what he saw under the microscope. He would like to impress upon the younger members who were taking up the use of the microscope for the the investigation of alloys, that it was on the lines he had suggested that they might do valuable work. What he had in mind was that brief papers should be presented to the Institute giving photo-micrographs obtained from castings made in any one of the commonly used foundry alloys, from metal in both the normal and abnormal conditions.

AUTHOR'S REPLY.

Mr. PRIMROSE, replying to the discussion, said that the alloy A, in Table I, compression was found to give a percentage of elongation of 13 on 1 inch. Referring to Dr. Hyman's remarks as to the physical properties of the Alpha and Alpha-beta brasses, he said he could assure Dr. Hyman definitely that the A specimen of Alpha brass came within the 70/30 range. He could quite understand the doubt as to its physical properties being as stated in the table, because the "A" metal brass had had to be forged in order to attain the values given. The brasses in Figs. 12 and 13 were as cast, and that in Fig. 14 was forged.

That might be the reason for the slight difference in physical properties that Dr. Hyman had commented upon.

In reply to Mr. Longden, he said he had not tried specially hot moulds for casting non-ferrous metal. It was obvious, of course, that the mould must not be in such a condition that moisture might condense on it; slight heating of the mould was found to be advantageous, but when it became too hot, troubles such as segregation arose.

In reply to Mr. Logan, he said he certainly had considered that a K.10 screen was one of the most generally useful. It was a fairly dark yellow. On one occasion he had used two of them as two screens of gelatine which alone were not quite dark enough. He believed they were equivalent to a K.10. He had not used the green filter much, but the yellow one he had found to be very useful for non-ferrous and even for some ferrous metals. With regard to the suggestion that 150 diameters was the highest magnification necessary for works practice, he said he had sometimes slightly exceeded that, especially where very small grain size was involved. As a rule, however, he liked to work in multiples of the lowest power obtainable with the ordinary lenses of the microscope. In many microscopes the lowest was 50, and could be worked up to 100, 200, 400 or 500 and 1,000 in simple multiples. He used a graph which had been prepared by micrometric measurement, and by looking at that graph he could see to what distance he must extend the camera in order to get a magnification of 200 or 500, as the case may be, instead of selecting a suitable place to photograph, and finding afterwards that it was 197½ or some such figure, whereas by a slight movement of the camera he could have got exactly 200 diameters.

The use of ultra-violet light might come into use to explore some of the points which even yet we were not certain about.

It was all very well to regard his Paper as a text-book, but he was afraid that it was subject to revision as progress continued; he had merely given what he had found up-to-date.

Replying to Mr. Ridsdale, with regard to colour photography, he said he had experience only of the "Lumiere" plates, and had found that after he had used them in the lantern a few times they became so dense as not to reproduce the colours on the screen. Mr. F. Law seemed to have got over the difficulty of colour transparency, and had exhibited some admirable examples of colour photographs, but whether they had ultimately become dense after continued use he did not know.

Finally, he thanked Mr. Lambert for his inspiring suggestions.

Mr. Louis Piedboeuf's Paper on "Results Obtained in the Improvement of the Qualities of Cast Iron."

This Paper was introduced by Mr. G. Masson (President of the Belgian Foundrymen's Association).

THE PRESIDENT, welcoming Mr. Masson, said he believed that this was the first time for four years on which the Institute had had the honour of welcoming the President of a foreign association.

MR. MASSON, addressing the meeting in French (his remarks were interpreted by the President), apologised for his inability to speak English, and also for the absence of Mr. Piedboeuf. The Paper, he said, was the result of the action of the Committee of the Belgian Foundrymen's Association. Its object was to give the results of tests made during recent years in the direction of improving the qualities of cast Iron. Mr. Massbn produced a fracture of Varlet's special iron, which exhibited quite a pearlitic structure, together with two photographs of Varlet's iron.

THE PRESIDENT reminded the members that Mr. Varlet had read a very valuable Paper before the Institute at Birmingham four years ago. He also thanked Mr. Masson for having introduced Mr. Piedboeuf's Paper.

DISCUSSION.

MR. HORACE J. YOUNG, F.I.C., said that in Table II reference was made to a Lanz iron in which the carbon + silicon = 3.80 to 4.20 per cent. As one who had practiced the Lanz process, he could give his assurance that that total could be anything one liked. The mould was heated according to the composition of the iron. Mr. Young also referred to the statement on page 4 of the Paper that the pearlitic cast irons produced by the Thyssen Company were "distinguished by Si = Mn = 1," and asked for an explanation of that. As to the suggestion in the Paper that if composition were altered one need not take into consideration the temperature of the mould, he said that all scientists would agree that all metals during cooling were affected by their cooling rates, no matter what their composition was. Grain size as well as structure must be taken into consideration. One of the things that mattered most was the stability of the pearlite, and that stability depended largely upon other things in the iron. For instance, when it had to resist repeated heatings; a large content of silicon was most undesirable. We must have the quality of steel as well as soundness of castings. If soundness of castings mattered to the extent suggested in the Paper, then very many steel castings, if not nearly all, would be rejected. However, engineers still used steel, and put up with the fact that many steel castings had defects. The same remarks applied to cast iron. As to the statement that the cast iron represented by point Z of Maurer's diagram gave a tensile strength of from 15.7 to 17.6 tons per sq. in., in spite of a phosphorus content of 0.8 per cent., by a purifying treatment carried out in the forehearth by alkaline substances, although he knew little about that treatment, which was very interesting, the same tensile strength could be obtained without that treatment in iron with 0.8 per cent. phosphorus. The tensile strength of cast iron was a very debatable point. He had made a great many Diesel castings by the hot and the cold mould processes which had given high tensile strengths, but there were other properties which were of greater importance. Therefore, he wished the author had given more data upon the growth, impact values, and so on, of these irons as stated casting thicknesses and weights.

New Companies.

C. B. Jackson & Company, Limited.—Capital £3,000 in £1 shares (1,000 7 per cent. cumulative participating preference and 2,000 ordinary). Heating engineers. Directors: C. B. Jackson, 85, Balmoral Road, Cricklewood, N.W.2; W. M. Hume, 5, Easton Grove, Birkenhead; and R. L. Smith, 52, Wynnstay Gardens, Kensington, W.

Edward Cowan & Company, Limited, 77, Bridge Street, Cardiff.—Capital £500 in £1 shares. Engineers. Directors: H. Solomon, Mrs. C. Solomon, and Mrs. S. Barnett.

F. E. W. Patents and Engineering Company, Limited, 1 and 2, South Avenue, Sandycombe Road, Kew Gardens.—Capital £10,000 in £1 shares.

Fozel Castings Company, Limited.—Capital £6,000 in £1 shares.

R. H. Armitage & Company, Limited, 29, Creswick Road, Acton, W.3.—Capital £1,000. Scrap metal dealers, etc. Directors: R. H. Armitage and J. Q. Shirreffs.

Sumner, Mayoh and Haley, Limited, 22, Buckingham Gate, S.W.1.—Capital £12,500 in 250,000 shares of 1s. each. Engineers.

Thompson and Munroe, Limited.—Capital £2,000 in £1 shares. Manufacturers of wire drawing machinery. Directors: J. Thompson, 32, Thornhill Road, Rastrick, Brighouse; and R. Munroe, 34, Thornhill Road, Rastrick, Brighouse.

MR. D. RAMSAY, a partner in Ramsay Bros., ironfounders, Whitehaven, has died at Workington at the age of 80.

MR. AND MRS. W. H. SHERBURN, of Rotherwood, Stockton Heath, celebrated their golden wedding recently. Mr. Sherburn is one of the best-known figures in Lancashire foundry circles, having been awarded the Oliver Stubbs gold medal some three years ago. Mr. Sherburn still acts in a consultative capacity to the Richmond Gas Stove Company at Warrington.

Cast Iron for Electrical Machines.

By J. H. Partridge, B.Sc. (Hons), (University of Birmingham).

(*Continued from page* 462.)

The Effect of Manganese.

In order to investigate the effect of manganese on the magnetic properties of cast iron, the manganese was varied whilst the silicon was kept constant. The silicon was added to give soundness and to make the specimens soft and machinable.

The chemical composition of the specimens is given in Table VIII.

TABLE VIII.—*Composition of the Manganese Series.*

Specimen	Mn.	Si.	T.C.	C.C.	G.C.
M1 ..	0.235	1.724	2.64	1.35	1.29
M2 ..	0.63	1.736	2.82	1.38	1.44
M3 ..	1.07	1.727	2.69	1.49	1.2
M4 ..	1.49	1.705	2.73	1.41	1.32
M5 ..	2.66	1.466	2.65	2.65	nil

The magnetisation and permeability curves are given in Fig. 5, and the magnetic properties in Table IX.

TABLE IX.—*Magnetic Properties of Manganese Series.*

Specimen	B max.	H max.	μ max.	H for μ max.	Remanence.
M1	10,900	100.13	264	15	4950
M2	11,225	99.96	260	17.2	4960
M3	11,016	99.59	241.2	20.2	5420
M4	10,240	93.9	234	16.6	5090
M5	8,420	100.0	160	30	4600

It is seen from the curves that manganese is prejudicial to good magnetic properties and should be as low as possible when high induction and high permeability are required. The decrease in the induction with increasing manganese content is shown in Fig. 7. The specimens were then annealed in a similar manner to the previous specimens, namely, they were surrounded by their own turnings in a closed iron box, heated to 875 deg. C. and allowed to cool very slowly. The magnetic properties of the annealed specimens are given in Table X, from which it is seen that annealing slightly raises the induction, the slight increase being probably due to removal of strain.

Manganese increases the hysteresis loss and the coercive force, but decreases the magnetic induction and remanent magnetism. Thus manganese should be kept as low as possible, when cast iron having high permeability, high maximum induction and low hysteresis loss is required.

Influence of Aluminium.

Aluminium was added to American washed iron

TABLE XI.—*Composition of the Aluminium Series.*

Specimen.	Al.	Mn.	Si.	T.C.	C.C.	G.C.
A1	0.31	trace	0.047	3.09	3.06	0.03
A2	0.62	,,	0.047	3.05	2.96	0.09
A3	1.03	,,	0.046	2.84	1.34	1.50
A5	1.23	,,	0.045	2.56	1.91	0.65
A6	3.00	,,	0.046	2.60	1.42	1.18

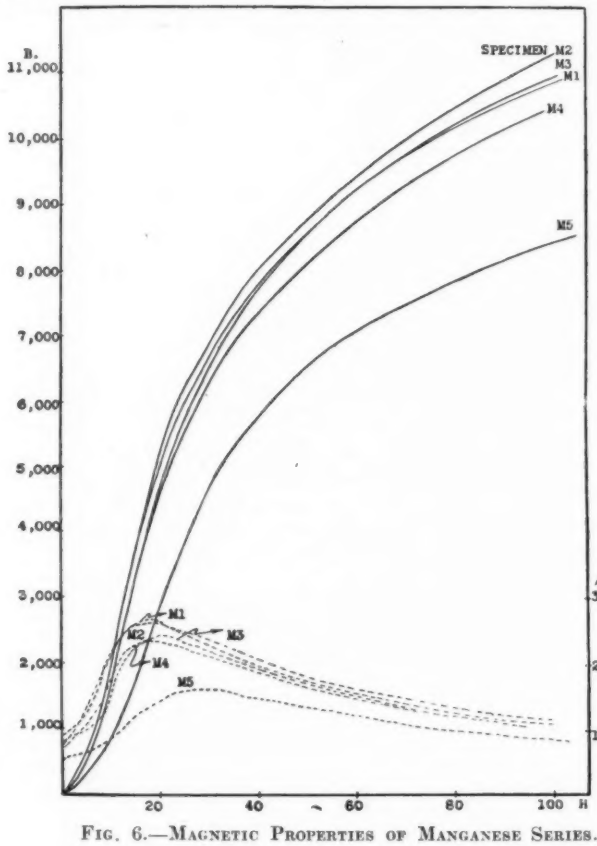


FIG. 6.—MAGNETIC PROPERTIES OF MANGANESE SERIES.

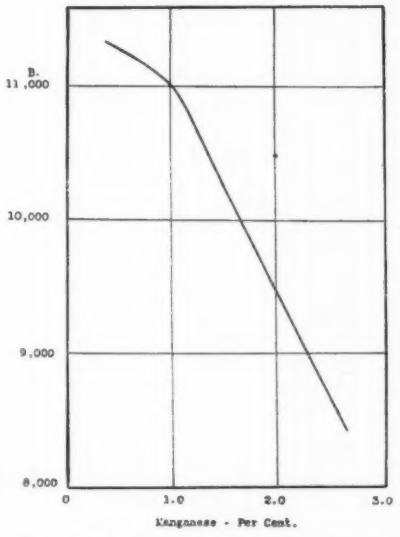


FIG. 7.—EFFECT OF MANGANESE ON THE INDUCTION.

TABLE X.—*Magnetic Properties of Heat-Treated Manganese Series.*

Specimen.	Maximum induction.	Remanent magnetism.	Coercive Force.	Hysteresis loss in ergs/ c.c. cycle for B=10,000	Hysteresis loss in Watts per lb.	Density.
M1	11,160	5550	9.5	Accidently	broken	7.337
M2	11,400	5930	9.5	28.200	17.403	7.345
M3	11,180	5800	11.0	29,550	18.551	7 397
M4	10,560	5440	12.0	31.600	19.350	7.405
M5	8,520	4760	20.0	35.000	21.061	7.538

to ascertain its effect on the magnetic properties of cast iron. Aluminium behaves like silicon in that it renders the iron sound and precipitates graphite. Thus silicon is not necessary. The analyses of the first series of specimens is given in Table XI.

Specimens A1, A2 and A3 were annealed at 900 deg. C. for fifteen minutes before machining. The magnetisation and permeability curves are given in Fig. 8, and a summary of the magnetic properties is given in Table XII.

TABLE XII.—*Magnetic Properties of the Aluminium Series.*

Specimen.	B max.	H max.	μ max.	H for μ max.	Remanent magnetism.
A1	10,530	100.13	319	13.2	5900
A2	10,510	99.15	289	15.0	5660
A3	9,980	99.59	245	18.0	4940
A5	8,780	99.25	125.5	42.75	3970
A6	7,950	101.03	105.2	38.5	4170

Thus there is a steady decrease in the maximum induction and remanent magnetism as the aluminium content is increased. The effect of annealing is very pronounced, the curves for specimens A5 and A6 being very much lower than those of the annealed specimens.

Before taking hysteresis loops, the specimens were annealed in their own turnings at 875 deg. C. and allowed to cool very slowly. Primary magnetisation curves and hysteresis loops were then determined. A summary of magnetic properties is given in Table XIII.

TABLE XIII.—*Magnetic Properties of Heat-Treated Aluminium Series.*

Specimen.	B max.	H max.	Remanence	μ max.
A1	10,700	102.7	6210	360
A2	10,540	101.1	5990	321
A3	10,370	100.13	5760	312
A5	13,470	99.4	4800	1045
A6	12,850	100.7	4600	1030

There is an increase in the maximum induction, maximum permeability and remanence of specimens A1, A2 and A3 on annealing. This is due to further graphisation of these alloys. Up to 1 per cent. aluminium causes a slight decrease in the induction, but the most noticeable feature is the extremely high induction of specimens A5 and A6. In the cast condition the inductions of these specimens were 8,776 and 7,950 c.g.s. respectively, whereas in the annealed condition they are 13,470 and 12,850 c.g.s. respectively. Moreover, the permeability of these specimens has been increased tenfold by annealing, as shown in Table XIV, which also gives the graphite analysis of the specimens before and after annealing.

The magnetisation and permeability curves for specimens A5 and A6 in the annealed condition are shown in Fig. 8. The extremely high induction of these specimens is largely due to the small

TABLE XIV.—*Graphite Content and Magnetic Properties of two Aluminium Alloys before and after Heat-Treatment.*

Specimen.	Cast condition.			Annealed.		
	μ max.	H for μ max.	Graphite.	μ max.	H for μ max.	Graphite.
A5	125.5	42.75	0.65	1045	2.5	2.1
A6	105.2	38.5	1.18	1030	3.0	2.45

amount of combined carbon, and to the distribution of the graphite. Table XV gives a summary of the properties of these specimens.

Aluminium, up to 1 per cent., apparently increases both the coercive force and the hysteresis loss, but further addition causes a considerable decrease. The coercive force and

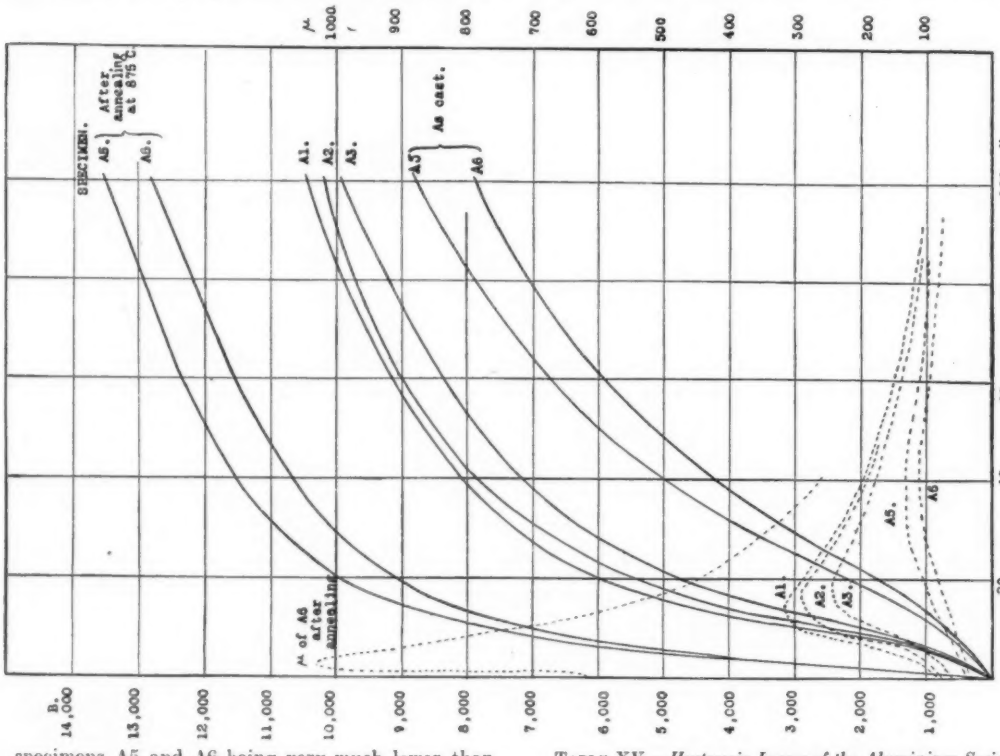


FIG. 8.—THE MAGNETIC PROPERTIES OF THE ALUMINIUM SERIES.

TABLE XV.—*Hysteresis Losses of the Aluminium Series*

Specimen.	Coercive force.	Hysteresis loss in ergs/c.c. per cycle for B = 10,000	Loss in Watts per lb. of metal.	Density.
A1	9.9	28,000	16.778	7.572
A2	13.0	36,210	21.590	7.611
A3	12.4	36,100	22.090	7.375
A5	3.4	9,000	5.908	6.908
A6	2.7	7,100	4.716	6.809

hysteresis loss of specimens A5 and A6 are very little greater than those of soft iron. Alloys containing from 1 to 4 per cent. of aluminium were then prepared and tested in the cast condition. The analysis of these specimens is given in Table XVI.

TABLE XVI.—*Composition of Second Series of Aluminium Alloys.*

Specimen.	Al.	T.C.	C.C.	G.C.	Si.	Mn.
A7	0.865	3.61	1.35	2.26	0.03	Trace
A9	1.52	3.63	1.48	2.15	0.03	,,
A10	2.23	3.52	1.63	1.89	0.02	,,
A11	2.50	3.64	1.34	2.30	0.023	,,
A12	2.83	3.50	1.59	1.91	0.025	,,
A13	3.60	3.61	1.36	2.25	0.018	,,
A14	4.09	3.42	1.57	1.85	0.02	,,

The primary magnetisation and permeability curves are given in Fig. 9, and a summary of the magnetic properties is given in Table XVII.

TABLE XVII.—*Magnetic Properties of the Second Series of Aluminium Alloys.*

Specimen.	B max.	H max.	μ max.	H for μ max.	Remanence
A7	9450	98.35	196	19.88	3850
A9	9155	100.13	199	16.20	3850
A10	8750	98.35	165	20.56	3580
A11	8440	104.80	158	18.12	3500
A12	8140	93.70	134	26.0	3040
A13	7260	98.31	109	32.36	3410
A14	6660	98.33	87	41.30	3210

TABLE XVIII.—*Hysteresis Losses of Second Series of Aluminium Alloys.*

Specimen.	Limits of induction between which the loop was determined	Coercive force.	Hysteresis loss in ergs/c.c./cycle.	Loss in Watts per lb. of metal.	Density.
A7	9600	13.4	31,750	20.213	7.123
A9	9100	12.7	30,335	20.083	6.851
A10	8800	14.4	30,810	19.453	7.184
A11	8500	14.8	31,880	20.448	7.075
A12	8100	18.4	39,790	25.460	7.090
A13	Could not be fitted into the yoke.				6.753
A14	6700	24.6	41,540	28.433	6.627

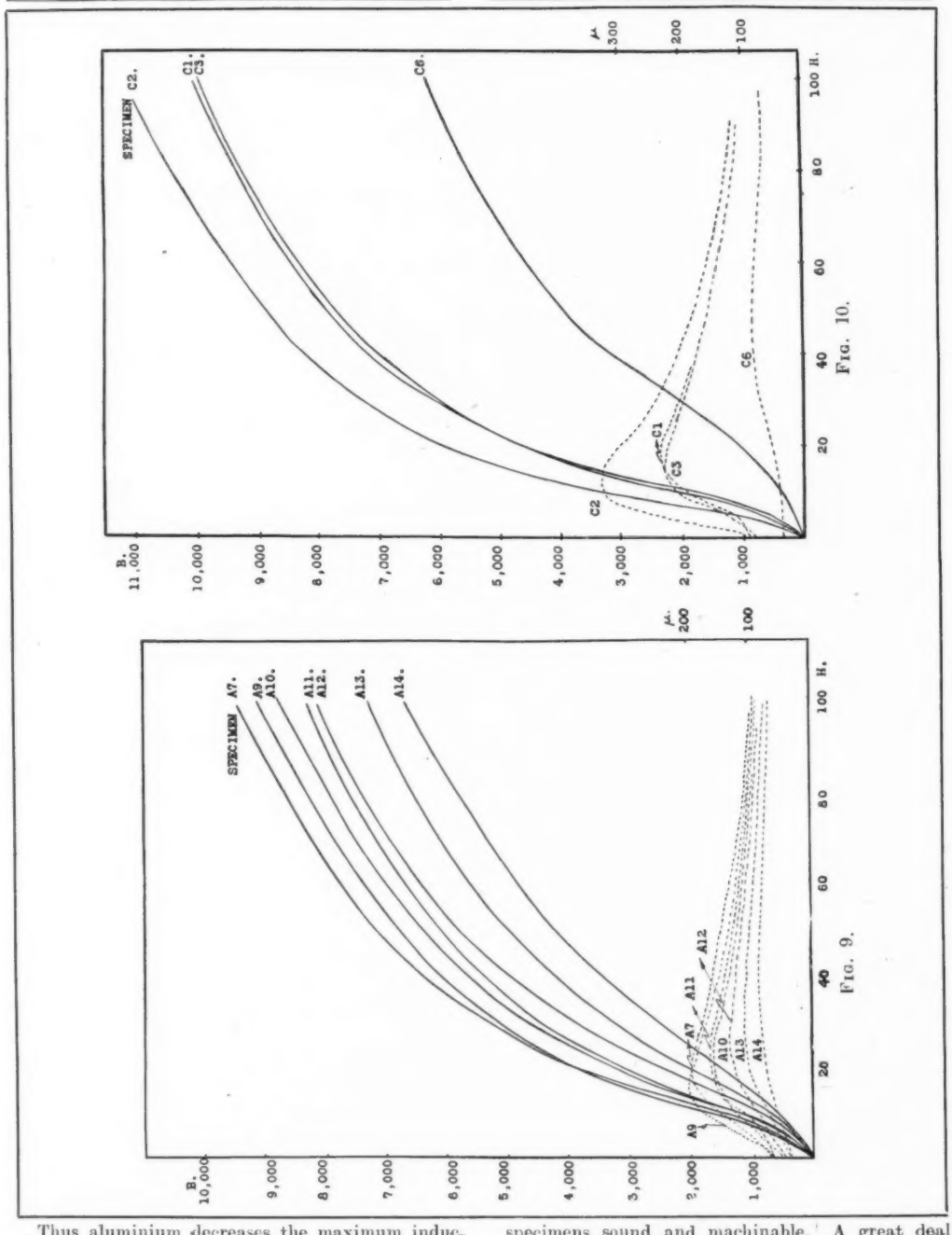


FIG. 10.

FIG. 9.

Thus aluminium decreases the maximum induction, the maximum permeability, and the remanent magnetism. The magnetic properties obtained from the hysteresis loops are given in Table XVIII.

Except in the case of specimen A7, aluminium increased the coercive force. The hysteresis loss first decreases and then increases.

Effect of Chromium.

In addition to the chromium, silicon had to be added to the washed iron in order to make the specimens sound and machinable. A great deal of difficulty was experienced in making these

TABLE XIX.—*Composition of Chromium Series.*

Specimen.	Si.	Cr.	Mn.	T.C.	C.C.	G.C.
C1	2.632	0.63	0.02	2.59	1.21	1.38
C2	3.627	1.06	Trace	2.42	0.94	1.48
C3	3.116	1.79	0.015	2.45	1.06	1.39
C6	1.71	7.51	0.01	2.10	2.10	nil

specimens, they had to be prepared in two heats, and they contained amounts of silicon varying from 1.7 per cent. to 3.6 per cent. The analysts of the specimens is given in Table XIX, and the magnetisation and permeability curves are shown in Fig. 10.

A summary of the chief magnetic properties is given in Table XX, from which it is seen that chromium is prejudicial to good magnetic properties.

TABLE XX.—*Magnetic Properties of the Chromium Series.*

Specimen.	B max.	H max.	μmax.	H for μ max.	Remanent magnetism.
C1	9,925	97.43	231	15.1	4460
C2	10,970	96.58	330	13.1	5150
C3	9,920	99.07	229.7	17.4	4160
C6	6,120	99.6	80	45	3310

It is difficult to draw accurate conclusions from specimens C1, C2, and C3, owing to the varying amounts of silicon. The induction of specimen C2 is high owing to the large percentage of silicon, whilst the induction of specimen C3 is not very much less than that of specimen C1, because the former contains 0.5 per cent. more silicon than the latter. The addition of chromium decreases the maximum permeability of the remanent magnetism, and increases the force at which this maximum permeability occurs.

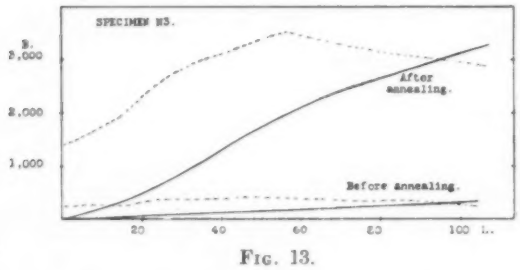


FIG. 13.

TABLE XXI.—*Hysteresis Losses of the Chromium Series.*

Specimen.	Remanent magnetism.	Coercive force.	Hysteresis loss in ergs/c.c. per cycle for B = 10,000.	Hysteresis loss in Watts per lb. of metal.	Density.
C1	5550	11.8	31,130	19.802	7.271
C2	5290	10.0	29,000	18.72	7.082
C3	4960	8.7	21,000	14.988	7.270
C6	3350	33.0	45,350	27.642	7.537

In the hysteresis tests, chromium appears to increase the coercive force and hysteresis loss, as shown in Table XXI.

Non-Magnetic Alloys.

Several bars containing various percentages of nickel were cast in order to determine the effect of this element on the magnetic properties of cast iron. However, only one of these bars could be machined. It is well known that nickel lowers the thermal transformation points of steel. Consequently a series of alloys containing progressively increasing amounts of nickel will be martensitic over a considerable range of composition. The bars in this martensitic range cannot be turned in a lathe. The bar which was machined consists mainly of austenite. The analysis (Specimen N3) is as follows:—

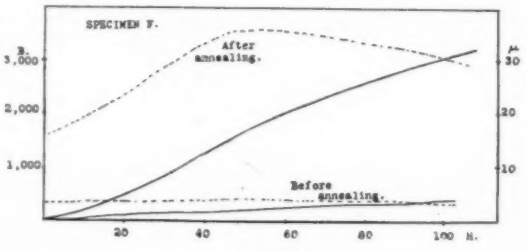


FIG. 14.

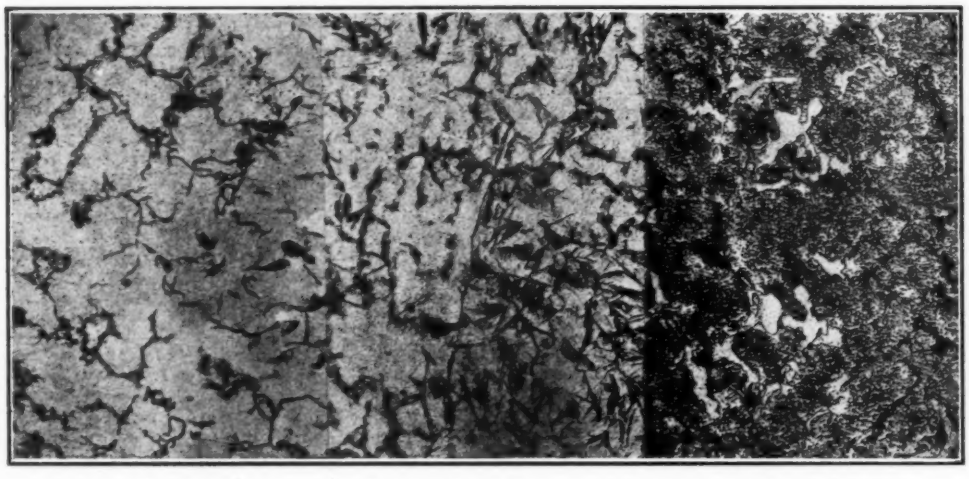


FIG. 11.
SPECIMEN N3,
ETCHED × 100.

FIG. 12.
SPECIMEN F.
ETCHED × 100.

FIG. 15.
SPECIMEN N3
(ANNEALED),
ETCHED × 100.

Specimen.	Ni.	Si	Mn.	T.C.	C.C.	G.C.	P.
N3	12.35	1.30	0.025	2.56	1.16	1.4	—
F	10.00	2.57	2.04	2.20	0.59	1.61	1.96

Specimen F was made after seeing a short paragraph in the technical Press on "No-Mag," which is a patented non-magnetic cast iron made by Messrs. Ferranti. The paragraph stated that "No-mag" consisted of 80 per cent. of cast iron, the additions being nickel and manganese, and that it was cast into very thin sections. The micro-structure of Specimen N3 is shown in Fig. 11, from which it will be noticed that the ground mass is austenite, and that there is a small amount of carbide present. Thus nickel causes the iron to remain in the austenitic condition and consequently the iron is non-magnetic. The micro-structure of Specimen F, shown in Fig. 12, consists of austenite containing a little martensite, an inter-granular constituent consisting of a mixture of cementite and phosphide eutectic, and graphite. The presence of this martensite made the iron extremely hard and difficult to machine.

The magnetic properties of "N3" and "F" are shown in Figs. 13 and 14 respectively, from which it will be seen that the specimens are feebly magnetic. Table XXII gives the chief magnetic properties of the specimens. It should be noted that the permeability scale in Figs. 13 and 14 is ten times the scale used in previous figures.

These specimens become magnetic on annealing, due to the austenitic breaking up and producing martensite. The structure of Specimen N3, after annealing is shown in Fig. 15.

TABLE XXII.—*Magnetic Properties of Two Nickel Alloys of Cast Iron.*

Specimen	B max.	H max.	μ max.	H for μmax.	Remanent magnetism.
N3 (as cast)	419	99.15	4.6	60	6
F4 ,,	377	99.61	3.8	60	nil
N3 annealed at 875°C.	3140	103.2	35.0	57	1330
F annealed at 875°C.	3280	105.5	33.7	46	1630

(To be continued.)

Trade Talk.

CONSIDERABLE damage has been caused by an outbreak of fire at the premises of the Iron and Horseshoe Company, Limited, Atlas Works, Victoria Road, North Acton.

JOSEPH KAYE & SONS, LIMITED, Lock Works, Leeds, have recently received an order from the Great Western Railway for 2,000 of their automatic wedge locks, including also their new combined cam striking plates.

THE IMPORTS OF FOREIGN IRON ORE at the Senhouse Dock at Maryport for the half-year ending June 30 amounted to 66,700 tons, compared with 43,100 tons for the last six months of 1925, and 63,350 tons at the corresponding period of last year.

RETURNS FROM THE Scottish shipbuilding yards for June show that twelve vessels of 18,521 tons gross were launched, as compared with 19,744 tons in May. The output for the six months was 80 ships of 158,552 tons, against 119 craft of 302,957 tons for the first half of the previous year.

AN AMALGAMATION is pending of the manufacturing facilities of the Daimler Company, Limited, of Coventry, and the Associated Equipment Company, Limited, of Walthamstow, E., and a new company, under the title of the Associated Daimler Company, Limited, is to be floated at a very early date.

E. G. APPLEBY & COMPANY, LIMITED, who sell the "Phœnix" electro-lifting magnets, manufactured by Steel, Peech & Tozer, Limited, of Sheffield, have received orders in the last ten days for nineteen of these magnets. Fifteen, including four large circular magnets, 62-in. diameter, have been ordered by one steelworks in this country.

AN IMPRESSION appears to have been created that recent financial difficulties would necessitate the closing down of Fuller's United Electric Works, at Chadwell Heath. We are able to state that the business is being carried on as usual under the control of Sir John Mann, as receiver and manager, and that there is no intention whatever of bringing its activities to an end.

AN AMERICAN FIRM has been successful in obtaining the contract for 10,000 tons of rails for the Heilungking provincial railway which were purchased through the South Manchuria Railway. During 1925 the following were the exports of rails from the various countries:—Germany, 288,272 tons; France, 237,002 tons; United Kingdom, 217,196 tons; Belgium, 168,332 tons; United States, 151,690 tons.

THE STEEL BAND CONVEYOR & ENGINEERING COMPANY, LIMITED, Barker Street Works, Parade, Birmingham, are acquiring the business carried on as Steel Belts, Limited. The stock and tools, etc., are being transferred to the former company's extensive works in Birmingham, whilst Mr. H. Blackburn, who has hitherto been managing director of Steel Belts, Limited, will join the Steel Band Conveyor Engineering Company, Limited, and remain in Manchester.

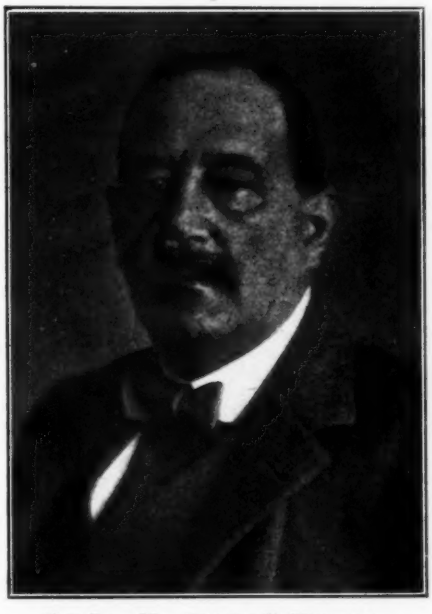
VICKERS, LIMITED, have recently completed an agreement under which the patents and designs of M.A.N. (Maschinenfabrik-Augsburg-Nürnberg A.G.), covering two-stroke heavy-oil engines, both single and double-acting, will be available for their use in the British Empire and Colonies for both marine and stationary purposes. British-built Vickers-M.A.N. engines embodying the joint experience of the two firms thus become available for installations of the largest powers.

DILLON, READ & COMPANY have offered in New York 30,000,000 dollars German United Steel Works Corporation twenty-five year six-and-a-half per cent. sinking fund mortgage gold bonds, Series "A," at the price of 96 and interest, New York terms. The issue was over-subscribed within half an hour of the opening of the subscription lists. The company will acquire four of the leading coal, iron and steel concerns in Germany, and will be the largest industrial unit in Europe, and one of the largest manufacturers of iron and steel in the world, ranking in productive capacity second only to the United States Steel Corporation.

Death of Mr. Charles P. Markham.

As we briefly announced last week, the death of Mr. Charles Paxton Markham, chairman of the Staveley Coal & Iron Company, Limited, and one of the foremost industrial magnates of the day, occurred with tragic suddenness on June 29. He was driving through the grounds of Ringwood Hall, Chesterfield, in a motor-car, when he suddenly collapsed, and died almost immediately. He was 61 years of age.

Mr. Markham probably devoted most of his time and energies to the Staveley Coal & Iron Company, Limited, and although the original works were founded some



THE LATE MR. CHARLES P. MARKHAM.

250 years ago, the immense development of the concern has taken place within the last few decades. The present magnitude of the vast industries controlled by the company is in itself a monument to Mr. Markham as an industrial magnate, for his was largely the guiding mind.

His firm of Markham & Company is now controlled by the Staveley Company.

Company Reports.

Davy Brothers, Limited.—Loss for twelve months, £12,415; brought forward, £4,605; debit balance carried forward, £7,810.

William Asquith (1920), Limited.—Net profit, £19,014; brought forward, £11,437; preference dividend, £17,751; carried forward, £12,700.

Belliss and Morcom, Limited.—Revenue balance, £36,862; interim ordinary dividend, 10 per cent. per annum; further dividend, making 15 per cent. for year.

Mond Nickel Company, Limited.—Profit, £454,074; ordinary dividend, 2s. 6d. per share for year, less tax; expenses of capital issue, £56,992; carried forward, £48,212.

The Mint, Birmingham, Limited.—Profit, £12,239; depreciation, £3,886; disposable sum, £19,768; final dividend on ordinary shares, 1s. per share, free of tax, making 10 per cent. for year; carried forward, £7,928.

Midland Iron Company, Limited.—Loss, £2,452; depreciation, £3,355; total deficit on year's working, £5,807; debit brought forward, £5,428; refund in respect of E.P.D., £6,922; debit carried forward, £4,314.

Platt Brothers & Company, Limited.—Profit, £253,381; brought forward, £86,942; total, £340,324; debenture interest and preference dividends, £108,007; interim ordinary dividend, £37,102; final dividend, 7½ per cent. on ordinary shares, making 10 per cent., less tax, for year; carried forward, £83,911.

Broughton Copper Company, Limited.—Profit, £63,677; brought forward, £5,257; debenture interest, £6,000; interest on loans, £102; interim dividend on preference shares, £2,550; interim dividend on ordinary shares, £11,900; available balance, £48,382; reserve account, £12,000; preference shares dividend, 5 per cent. for six months, £2,550; ordinary final dividend 10 per cent., making 15 per cent. for year, less tax, £25,800; carry forward, £10,032.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—The conditions of stringency in pig-iron supplies, noted in previous reports, are rapidly approaching the stage of exhaustion, and on Tees-side markets it is at the moment difficult, if not practically impossible, to obtain even small parcels of foundry material, and then only at prices prohibitive to the ordinary buyer. As a matter of fact, there is only one firm in the district still in a position to supply, while an advance of no less than 8s. per ton since recent markets in the price of No. 3 G.M.B. is an accurate measure of the scarcity of Cleveland pig-iron. As a result, current quotations can only be termed nominal on the basis of 84s. per ton for No. 3 G.M.B., pig-iron, No. 1 standing at 86s. 6d., No. 4 foundry at 83s., and No. 4 forge at 82s. 6d. per ton.

East Coast hematite is a little firmer. Although stocks have been reduced pretty considerably during the last few weeks, there are still fair quantities on the ground, and there has accordingly been no runaway in prices. At last week's market 79s. per ton appeared to be a minimum figure, and some sellers were asking rather more. On the North-West Coast prices are unchanged, with Bessemer mixed numbers £4 2s. 6d. per ton, c.i.f. Welsh ports, £4 7s. 6d. per ton delivered at Glasgow, £4 8s. to £4 10s. per ton delivered at Sheffield, £4 15s. to £4 16s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—In this area there are still limited supplies of Midland makes of pig on offer, but in few cases are the quantities of any importance, and mostly they can be bought only at high prices. Derbyshire iron, for example, which, before the stoppage, could be obtained at round 75s. per ton, delivered, has been lately offered at 93s. 6d., while for Staffordshire from 97s. to 98s. is the range of prices mentioned on this market for any available lots. Scottish No. 3 is steady, and little changed on the week at round 97s. 6d. per ton.

THE MIDLANDS.—Markets in these districts remain practically lifeless, but there has been a little North Staffordshire foundry iron on offer at 90s. per ton at the furnaces, and a fair amount of Cleveland is still coming forward. The price has stiffened, however, and No. 3 is quoted at 100s. delivered station, with No. 1 at 103s. 6d. per ton. Scotch iron has, however, been brought into this area, the price of which works out at about 102s. 6d. to 105s. per ton, delivered station or siding.

SCOTLAND.—With the nearer approach of the summer holidays, business in foundry iron is tending to still smaller dimensions. At the same time, makers report that deliveries are pretty steady, so that stocks are being substantially reduced, and makers are only prepared to sell limited quantities owing to the uncertainty as to when blast furnaces may be again producing. Some makers have again advanced their prices, and as high as 82s. 6d. is being quoted for No. 3 Scotch at the furnaces.

Scrap.

In common with other foundry materials, the demand has considerably slowed down of late, and in Scotland deliveries of such as heavy machinery cast-iron, ordinary heavy cast-iron scrap, cast-iron railway chairs, and piling wrought-iron scrap, is of small account, although prices for these are being maintained, particularly for all classes of the first named, on account of the scarcity of pig-iron and the firming in price of that commodity.

Metals.

Copper.—Although some slowing down of consumption is necessarily consequent upon those industries largely dependent upon base metals in their manufactures, the market for standard copper has remained throughout fairly steady, with a slightly better tendency in forward business. At the same time, both wiredrawers and cable makers have been buying fair quantities, but practically all for immediate consumption, which tends to suggest that consumers' stocks in Great Britain are dangerously low. The supply of second-hand fine copper is seemingly restricted, and dealers are, as a rule, asking terms at above those accepted by producers, so that the latter have had better opportunities to secure orders.

Official closing prices of standard copper have been as under :—

Cash : Thursday, £56 17s. 6d. ; Friday, £56 15s. ; Monday, £57 2s. 6d. ; Tuesday, £57 2s. 6d. ; Wednesday, £57 2s. 6d.

Three Months : Thursday, £57 15s. ; Friday, £57 10s. ; Monday, £57 17s. 6d. ; Tuesday, £57 17s. 6d.

Tin.—During the past few weeks operations have been on a fairly heavy scale, and the tone has been very good throughout on active American buying of both tin afloat and for shipment. The c.i.f. sales effected in the East have been considerably larger, and values correspondingly higher. Prominent support has been more or less in evidence, and this has caused the short interest to be rather fidgety, in face of brighter statistical prospects. Continental buying has been on a fair scale, but the home demand, of course, is kept down by the critical industrial situation.

Official closing prices of standard tin have been as follow :—

Cash : Thursday, £273 17s. 6d. ; Friday, £273 10s. ; Monday, £275 10s. ; Tuesday, £277 ; Wednesday, £276 7s. 6d.

Three Months : Thursday, £273 15s. ; Friday, £273 10s. ; Monday, £275 15s. ; Tuesday, £277 5s. ; Wednesday, £276 12s. 6d

Spelter.—Notwithstanding the gradual suspension of the galvanising industry, the market for ordinary brands of spelter has been exceptionally firm, and, despite minor fluctuations, values are well maintained at the higher level. On the whole, sellers have maintained quite a reserved attitude, but the demand for the metal has naturally fallen away, in view of the unsatisfactory conditions at home. The Belgian and Silesian output is increasing, which apparently is upsetting the reduction in American production, but Continental consumers appear to be able to absorb the surplus, particularly in Germany.

The following are the week's prices :—

Ordinary : Thursday, £33 11s. 3d. ; Friday, £33 10s. ; Monday, £33 15s. ; Tuesday, £33 17s. 6d. ; Wednesday, £33 16s. 3d.

Lead.—In the market for soft foreign pig, profit-taking has recently been somewhat conspicuous. Buyers, however, have always appeared at the lower levels to take advantage of cheaper prices. The influence of foreign orders has been very marked. Consumers here have viewed the metal with distrust for some time, and the improved situation elsewhere carries little weight.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £30 5s. ; Friday, £30 2s. 6d. ; Monday, £30 1s. 3d. ; Tuesday, £30 7s. 6d. ; Wednesday, £30 15s.

COLTNESS IRON CO., LTD.

Makers of the well-known and old-established

"COLTNESS" BRAND OF HIGH CLASS SCOTCH PIG IRON

FOUNDRY. No. 1, No. 3, No. 4. } STANDARD GRADES { HEMATITE. No. 1, No. 3, No. 4.

Works :— Newmains, Lanarkshire.

PRICES, ANALYSES, ETC., MAY BE OBTAINED ON APPLICATION TO THE GLASGOW OFFICE.

Office :— 75, Bothwell St., Glasgow, C.2.

"SERVICE GRC FIRST"

HAVE YOU A REFRACTORY PROBLEM?

Have you a furnace in which the Bricks will not stand up to the work?

Have you difficulty in getting a facing sand to strip freely?

Or a core to break up and run out?

IT IS OUR BUSINESS AND PLEASURE TO ADVISE AND ASSIST YOU FREE OF CHARGE

GENERAL REFRACTORIES CO., LTD.,
SHEFFIELD.

BCM/OK9
LONDON.

No need to try and remember our name in case it is unfamiliar to you. This is our British Monomark. Envelopes addressed simply thus will be delivered to us by arrangement with the G.P.O.

THE FOUNDRY TRADES EQUIPMENT & SUPPLIES ASSOCIATION LTD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	57	2	6
Three months ..	57	17	6
Electrolytic	64	15	0
Tough	62	0	0
Best selected ..	62	10	0
Sheets	90	0	0
India	74	0	0
Wire bars	65	0	0
Do. prompt ..	64	15	0
Do. July–August	64	17	6
Ingot bars	64	15	0
H.C. wire rods ..	69	7	6
Off. av. cash, June 56	16	9	9/11
Do., 3 mths. June57	14	1	1/11
Do.,Sttlmnt, June56	17	1	10/11
Do., Electro, June64	16	7	1/2
Do., B.S., June .. 62	4	2	
Aver. spot price copper, June .. 56	17	2	
Do.,wire bars, June65	11	4	1/2
Solid drawn tubes		12	1/2d.
Brazed tubes ..		12	1/2d.
Wire		9	1/2d.

BRASS.

Solid drawn tubes ..	11 1/2d.
Brazed tubes	13 1/2d.
Rods, drawn	10 1/2d.
Rods, extd. or rlld. ..	7 1/2d.
Sheets to 10 w.g ..	10 1/2d.
Wire	9 1/2d.
Rolled metal	9 1/2d.
Yellow metal rods ..	7 1/2d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8 1/2d.

TIN.

	£	s.	d.
Standard cash ..	276	7	6
Three months ..	276	12	6
English	274	10	0
Bars	278	10	0
Straits	286	0	0
Australian	278	0	0
Eastern	283	10	0
Banca	284	0	0
Off.avr. cash,June268	9	5	10/22
Do.,3 mths.,June267	13	0	2/22
Do.,Sttlmt. June268	8	7	7/11
Aver. spot., June 268	9	6	

SPELTER.

	£	s.	d.
Ordinary	33	16	3
Remelted	33	0	0
Hard	28	10	0
Electro 99.9 ..	36	10	0
English	34	7	6
India	31	5	0
Zinc dust	42	0	0
Zinc ashes	15	0	0
Off. aver., June	33	6	5 1/2
Aver., spot, June	33	4	10 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	30	15	0
English	32	0	0
Off. average, June 30	1	3	15/22
Average spot, June 29	19	8	1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	0	0
Do. V.M. ex whf.	38	10	0
Rods	44	0	0
Boiler plates ..	38	10	0
Battery plates ..	38	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	79	10	0
Chinese	60	0	0
Crude	30	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	15	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon			
25%	9	0	0
45/50%	11	5	0
75%..	19	15	0
Ferro-vanadium—			
35/40% ..	15/- lb. va.		
Ferro-molybdenum—			
70/75% c. free ..	5/10 1/2 lb.		
rro-titanium—			
23/25 carbonless	11 1/2d. lb		
Ferro-phosphorus, 20/25%,	£17	0	0
Ferro-tungsten—			
80/85%,c.fr. ..	1/4 1/2 lb.		
Tungsten metal powder—			
98/99% ..	1/10 1/2 lb.		
Ferro-chrome—			
2/4% car. ..	£33	10	0
4/6% car. ..	£22	0	0
6/8% car. ..	£21	10	0
8/10% car. ..	£20	15	0
Ferro-chrome—			
Max. 2% car.	£37	2	6
Max. 1% car.	£43	10	0
Max.0.70%car.	£54	10	0
70%, carbonless	1/5 1/2 lb.		
Nickel—99%,			
cubes or pellets ..	£170		
Cobalt metal—98/99%	10/- lb.		
Aluminium 98/99%	£118		
Metallic Chromium—			
96/98%	3/6 lb.		
Ferro-manganese (net)—			
76/80%, loose	£15	0	0
76/80%, packed	£16	0	0
76/80%, export	£14	5	0
Metallic manganese—			
94/96%, carbonless	2/- lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten ..	2	6
Finished bars, 18% tungsten ..	3	0

Per lb. net, d/d buyers' works.

Extras—
- Rounds and squares 3 in. and over .. 4d.lb.
- Rounds and squares under 1/4 in. to 1/2 in. 3d. lb.
- Do. under 1/4in. to 1/16 in. .. .. 1/- lb.
- Flats, 1/2in. × 1/4in. to under 1 in. × 1/8 in. 3d. lb.
- Do. under 1/2in. × 1/4in. 1/- lb
- Bevels of approved sizes and sections 6d. lb.
- Bars cut to length 10% extra

Scrap from high-speed tool steel—
- Scrap pieces .. .. 3d.
- Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.
Hvy. steel	3	7	6
Bundled steel & shrngs.	3 3 0 to	3	6 0
Mixed iron & steel	3 0 0 to	3	3 0
Heavy cast iron	3	5	0
Good machinery for foundries ..	3	5	0
Cleveland—			
Heavy steel ..	3	1	0
Steel turnings ..	2	6	0
Cast iron borings	2	5	0
Heavy forge ..	4	2	6
Bushelled scrap	3	10	0
Cast-iron scrap	3	11	0
Lancashire—			
Cast-iron scrap	3 2 6 to	3	10 0
Hvy. wrought ..	3	2	6
Steel turnings ..	2	2	0

London — Merchants' buying prices delivered yard.

Copper (clean)..	48	0	0
Brass (clean) ..	39	0	0
Lead (less usual draft)	27	0	0
Tea lead ..	22	0	0
Zinc	22	0	0
New aluminium cuttings ..	80	0	0
Braziery copper	44	0	0
Gunmetal ..	45	0	0
Hollow pewter	180	0	0
Shaped black ewter ..	132	0	0

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	86/6
Foundry No. 3 ..	84/-
Foundry No. 4 ..	83/-
Forge No. 4	82/6
Hematite No. 1 ..	79/6
Hematite M/Nos. ..	79/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/6
„ d/d Birm.	95/9
Midlands—	
Staffs. common* ..	—
„ No. 4 forge ..	—
„ No. 3 foundry	—
Shrops. basic	—
„ Cold blast, ord.*	—
„ „ roll iron* ..	—
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3 ..	—
Derbyshire forge ..	—
„ fdry. No. 3 ..	90/-
„ basic	—
Scotland—	
Foundry No. 1 ..	87/6
„ No. 3 ..	82/6
Hem. M/Nos.	79/-
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3 ..	—
Lincs. forge	—
„ fdry. No. 3 ..	—
E.C. hematite	91/-
W.C. hematite ..	89/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3.. ..	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3 ..	93/6
Northants foundry No. 3	—
Dalzell, No. 3	110/-
Summerlee, No. 3 ..	97/6
Glengarnock, No. 3 ..	97/6
Gartsherrie, No. 3 ..	97/6
Monkland No. 3	97/6
Coltness, No. 3	97/6
Shotts, No. 3	97/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars(cr.)	11 5 0 to			12 0	0	
Angles				11 10	0	
Tees to 3 united ins.				12 0	0	
Nut and bolt	10 5 0 to			10 7	6	
Hoops	14 0 0 to			15 0	0	
Marked bars (Staffs.) f.o.t. ..				14 0	0	
Gas strip				12 10	0	
Bolts and nuts ¾ in. × 4 in. ..				15 5	0	
Steel—						
Ship plates				8 2	6	
Boiler plts. ..				11 5	0	
Chequer plts. ..				10 0	0	
Angles				7 7	6	
Tees				8 7	6	
Joists				7 7	6	
Rounds and Squares 3 in. to 5½ ins. ..				8 0	0	
Rounds under 3 in. to ⅜ in.				7 15	0	
Flats, over 5 in. wide and up ..				8 10	0	
Flats, 5in. to 1½in.				7 10	0	
Rails, heavy ..				8 0	0	
Fishplates				12 0	0	
Hoops (Staffs.) ..				10 10	0	
Black sheets, 24g.				10 17	6	
Galv. cor. sheets, 24g.				16 10	0	
Galv. fencing wire 8g. plain				13 0	0	
Billets, soft ..				6 10	0	
Billets, hard ..				8 2	6	
Sheet bars				6 5	0	
Tin bars d/d ..				6 5	0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	22.76
No. 2 foundry, Valley	19.76
No. 2 foundry, Birm.	21.00
Basic	19.76
Bessemer	20.76
Malleable	19.76
Grey forge	19.26
Ferro-mang. 80% d/d	88.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28..	3.10
Sheets, galv., No. 28 ..	4.30
Sheets, blue an'l'd, 9 & 10	2.30
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
„ furnace	—
Durham & North.	
„ foundry	—
„ furnace	—
Other Districts, foundry	—
„ „ furnace (basis)	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	25/-
„	28×20, „	50/-
„	20×10, „	—
„	18¾×14, „	—
C.W.	20×14, „	23/3
„	28×20, „	—
„	20×10, „	—
„	18¾×14, „	—

Terneplates 28×20, 37/- per box basis f.o.b.

SWEDISH IRON.

Bars,hammered	£18/10 to £19/0
Rolled Ord.	£15/15/0 to £16/5/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 5 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes	*Fittings*
Gas	60%	50%
Water	55%	45%
Steam	50%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

		£	s.	d.	
July	1	56	17	6	No change
,,	2	56	15	0	dec. 2/6
,,	5	57	2	6	inc. 7/6
,,	6	57	2	6	No change
,,	7	57	2	6	,, ,,

Electrolytic Copper.

		£	s.	d.	
July	1	64	10	0	dec. 5/-
,,	2	64	10	0	No change
,,	5	64	10	0	,, ,,
,,	6	64	10	0	,, ,,
,,	7	64	15	0	inc. 5/-

Standard Tin (Cash).

		£	s.	d.	
July	1	273	17	6	inc. 37/6
,,	2	273	10	0	dec. 7/6
,,	5	275	10	0	inc. 40/-
,,	6	277	0	0	,, 30/-
,,	7	276	7	6	dec. 12/6

Tin (English ingots).

		£	s.	d.	
July	1	273	10	0	inc 70/-
,,	2	273	0	0	dec. 10/-
,,	5	275	0	0	inc 40/-
,,	6	276	10	0	,, 30/-
,,	7	274	10	0	dec. 40/-

Zinc Sheets (English).

		£	s.	d.	
July	1	42	0	0	No change
,,	2	42	0	0	,, ,,
,,	5	42	0	0	,, ,,
,,	6	42	0	0	,, ,,
,,	7	42	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
July	1	33	11	3	dec. 2/6
,,	2	33	10	0	,, 1/3
,,	5	33	15	0	inc. 5/-
,,	6	33	17	6	,, 2/6
,,	7	33	16	3	dec. 1/3

Lead (English).

		£	s.	d.	
July	1	31	10	0	dec. 5/-
,,	2	31	10	0	No change
,,	5	31	10	0	,, ,,
,,	6	31	15	0	inc. 5/-
,,	6	32	0	0	,, 5/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 5 6	2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 0
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12 6	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2½
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	—	—	—	—	—	—	3 17 4½

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XUM

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